FAA-E-2661a
January 15, 1985

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

NATIONAL AIRSPACE DATA INTERCHANGE NETWORK.

1. This specification describes the operation,technical and programming requirements for the National Airspace Data Interchange Network.

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DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION SPECIFICATION

NATIONAL AIRSPACE DATA INTERCHANGE NETWORK

(NADIN)

1. SCOPE

1.1 Scope

This specification describes the operation, technical and programming requirements for the National Airspace Data Interchange Network (NADIN) designed to receive, process, and transmit digital data (at various speeds, codes, and formats) presently being, or to be, handled by the following telecommunication (record) systems:

a. NASNET
b. AFTN (U.S. operations only)
c. Area and Supplemental B
d. Center B
e. Utility B
f. WMSC
g. FSAS
h. FDIO
i. NFDC/(CNS)
j. IAFC (AFCJCC)

In addition, the NADIN provides communication interfaces to the following external users and/or telecommunication record systems:

a. International AFTN
b. National Weather Service
c. Carswell Air Force Base
d. ARINC/Eastern Airlines

1.1.1 Configuration

The NADIN will consist of two geographically separated data switching centers and a network of concentrators and modems interconnected by commercially provided leased line services, with dial back-up provided.

1.2 Classification

Three classes of equipment are covered by this specification:

a. Processor-controlled data switching centers which consist of: computing elements, memory elements, input/output elements and adapter units to provide the required interfaces to remote concentrators, terminals, and computer-oriented peripheral devices including all required software.

REVISED JANUARY 18, 1984

b. Data concentrators consisting of stored program digital computers and associated support equipment which will be the local interface to and from NADIN subscribers and to the switching centers.

c. Peripheral and ancillary equipment necessary for system operation.

2. APPLICABLE DOCUMENTS

2.1 FAA, ICAO Documents, and Other Publications

The following specifications and standards of the issue in effect on January 4, 1977 (unless otherwise noted) form a part of this specification and are applicable only to the extent specified herein.

2.1.1 FAA Specifications

FAA-D-2494/1/2/3	Instruction Book Manuscripts Technical: Equipment and Systems Requirements: Preparation of Manuscripts: Printing Instructions.
FAA-G-2100/1/3/4/5	Electronic Equipment; General Requirements.
FAA-E-2473	Uninterruptable Power System, Modular, Solid-State.
FAA-E-163	Rack, Cabinet and Open Frame Types.
FAA-G-1210	Provisioning Technical Documentation.
FAA-G-1375	Spare Parts - Peculiar for Electronic, Electrical and Mechanical Equipment.
FAA-E-2552	Technical Training.
FAA-E-2586	Data Terminal Equipment Keyboard Display & Printer Set.
FAA-E-2306	Coded Time Source and Auxiliaries.

2.1.2 FAA Standards and Drawings

FAA-STD-012	Paint Systems for Equipment.
FAA-STD-016	Quality Control Program Requirements.
FAA Drawings B-21216	Nameplates.

2.1.3 International Civil Aviation Organization Manual (ICAO)

Annex 10, Vol. 1 Aeronautical Telecommunications.

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Annex 10, Vol. 1 Aeronautical Telecommunications.

Annex 10, Vol. 2	Aeronautical Telecommunications.
DOC 8259 - COM	Manual on the Planning and Engineering of the Aeronautical Fixed Telecommunication Network.
DOC 8126 AN/872	Aeronautical Information Services Manual.
ADIS Panl Reports	Reports of the Fifth, Sixth and Seventh Meetings of the ICAO/ADIS Panel.

2.1.4 FAA Orders, Regulations and Reports

7110.80	Data Communication.
6180.4	National Airspace Data Interchange Network (NADIN) Cutover
FAR Part 189	Use of Federal Aviation Agency Communications Systems.

2.1.5 Other Publications

The following Federal Information Processing Standards Publication Series (FIPS PUB), Electronic Industries Association (EIA), American National Standards Institute (ANSI) Documents, Military Standards, and International Telegraph and Telephone Consultative Committee (CCITT) Documents of the issues in effect on January 4, 1977 (unless otherwise noted) form a part of this specification and are applicable to the extent specified herein:

FIPS PUB 1	Code for Information Interchange.
FIPS PUB 3	Recorded Magnetic Tape for Information (800 CPI, NRZI).
BSR-X3.66	Deleted.
FED-STD-1005	Telecommunications, coding and modulation requirements for nondiversity 2400 bit/second modem.
FIPS PUB 11	Vocabulary for Information Processing.
FIPS PUB 13	Rectangular Holes in Twelve-Row Punched Card.
FIPS PUB 14	Hollerith Punched Card Code.
FIPS PUB 16	Bit Sequencing of the Code for Information Interchange in Serial-by-Bit Data Transmission.
FIPS PUB 17	Character Structure and Parity Sense for Serial-by-Bit Data Communication in the Code for Data for Information Interchange.

FIPS PUB 18	Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the Code for Data for Information Interchange.
FIPS PUB 20	Guidelines for Describing Information Interchange Formats.
FIPS PUB 22	Synchronous Signalling Rates Between Data Terminals and Data Communication Equipment.
EIA-STD-RS-366	Interface Between Data Terminal Equipment and Automatic Calling Equipment for Data Communications.
EIA-STD-RS-232	Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange.
EIA-STD-RS-449	Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange.
EIA-STD-RS-404	Standard for Start-Stop Signal Quality Between Data Terminal Equipment and Non-Synchronous Data Communication Equipment.
EIA-STD-RS-269	Synchronous Signalling Rates for Data Transmission.
ANSI X3.24	American National Signal Quality at Interface Between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission.
ANSI X3.27	Magnetic Tape Labels for Information Interchange '69.
ANSI X3.28	American National Standard Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communications Links.
ANSI X3.40	Unrecorded Magnetic Tape for Information Interchange. (9-track 200 and 800 CPI, NRZI, and 1600 CPI, PE).
ANSI X3.66	American National Standard for Advanced Data Communication Control Procedures (ADCCP).
MIL-STD-461, 462	Electromagnetic Interference Characteristics Requirements for Equipment.
MIL-STD-721	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety.

MIL-STD-785	Reliability Program for Systems, Equipment Development and Production.
MIL-E-17555	Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of.
MIL-P-40023	Paper, Teletypewriter, Continuous Flatfold.
ISO-3309	Deleted.
CCITT Recommendation V.35	Data Transmission at 48 Kilobits per Second Using 60- to 108 K Hz Group Band Circuits.

Bell System Data Communications Technical References.

International Business Machines Document IBM-7289-2	IBM Peripheral Adapter-Module Field Engineering, Maintenance Manual 9020 Systems
CCITT V.25	Automatic calling and/or answering equipment on the general switched telephone network, including disabling of echo suppressors on manually established calls.
CCITT V.29	Ninety-six hundred bits per second modem standardized for use on leased telephone-type circuits.
IBM 9020	Design Data.
IBM Document, File #TP-09, Order Number GA27-3004-2	BSC Interface "General Information, Binary Synchronous Communication".

National Electrical Code NFPA-70-1975.

FCC Tariff #260.

Coded Time Source (CTS) Instruction Book TI-6130.4.

2.1.6 Applicability of Listed Documents

The contractor is expected to use his professional judgement to select from many alternative methods to meet the functional requirements of this specification. If the contractor's design utilizes hardware or software within the scope of these specified documents (see Section 2.1.5), the documents shall apply.

Information on obtaining copies of the standards issued by the ANSI and ISO documents may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018. Information on obtaining copies of the ICAO documents may be obtained from Secretary General of ICAO, P.O. Box 400, Succursale: Place De L' Aviation International, 1000 Sherbrook Street, W.; Montreal, Quebec, Canada H3A 2R2.

3. REQUIREMENTS

3.1 Equipment, Programs, and Services to be Furnished by the Contractor

The contractor shall provide all necessary services, materials, and facilities, except as otherwise provided herein, to fabricate, test, deliver, and install the equipment and programs as required by this specification in the quantities and at the times required by the contract. Any feature or item necessary for proper operation in accordance with the requirements of the contract shall be incorporated even though that item or feature may not be specifically described herein. In addition, the contractor shall provide all necessary services and material to prepare, reproduce, and provide engineering analysis, reports, computer programs, and documentation as specified herein.

3.2 Definitions

Communication terms used in this specification that are not included below are defined in accordance with Federal Information Processing Standard - FIPS 11, Vocabulary for Information Processing.

Active Element. Those equipment units or elements of NADIN switches and concentrators (e.g., computing elements, random access bulk storage units, etc.) that are required or actively engaged in the processing of operational data in any given mode.

Communication Facilities. The equipment and services provided by one of the common carriers for data and voice transmission.

Computer Program Subsystem. See Section 3.5.1.

Data Reduction and Analysis (DR&A) Programs. See Section 3.5.4.4.2.

Element. Any portion of the NADIN equipment complex that, under program control, can be activated or deactivated and replaced by an identical redundant portion.

Excess Capacity. The capacity that exists in hardware and software which can be used for recovering from system failure and performing nonoperational functions, with elements available to replace failed active elements.

FTS. The Federal Telecommunications System administered by the General Services Administration (GSA).

Information on obtaining copies of the standards issued by the ANSI and ISO documents may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018. Information on obtaining copies of the ICAO documents may be obtained from Secretary General of ICAO, P.O. Box 400, Succursale: Place De L' Aviation International, 1000 Sherbrook Street, W.; Montreal, Quebec, Canada H3A 2R2.

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Excess Capacity. The capacity that exists in hardware and software which can be used for recovering from system failure and performing nonoperational functions, with elements available to replace failed active elements.

FTS. The Federal Telecommunications System administered by the General Services Administration (GSA).

High Speed Circuit. Circuit operating in excess of 9600 b/s, that may be bit serial or byte serial.

Inactive Element. Those equipment units or elements that are not available to the operational NADIN for an extended period of time. Typical reasons for nonavailability include component replacement or element power-off.

Low Speed Circuit. A communication circuit operating at data signaling rates of 50 up to 300 b/s.

KVDU. Keyboard Video Display Unit.

Medium Speed Circuit. A communication circuit operating at data signaling rates from 300 to 9600 bits per second.

Modem. A modulator-demodulator, an equipment that connects data terminal equipment to a communication line.

Node. The equipment and functional elements comprising a switching center or concentrator. A node is not considered to contain the communication facilities provided by a common carrier for data and voice transmission.

Offline Maintenance. Maintenance of elements during periods when the elements are not actively engaged in NADIN operational functions nor under the control of the online system.

Offline Maintenance Programs. See Section 3.5.4.3.

"Off-the-Shelf" Equipment. To qualify as Off-the-Shelf Equipment, a unit of equipment must meet one or more of the following criteria:

a. It is identical to equipment used as an integral element of at least one currently operational system; adequate maintenance procedures have been developed for the equipment; and maintenance records are available for examination by the FAA.

b. It is similar to current operational equipment that is used in at least one operational system; adequate maintenance procedures have been developed for the equipment; and maintenance records are available to the FAA; the differences from the currently operational equipment are of minor nature and do not affect the operating speed or internal operating techniques.

c. It is currently in the final phases of design; its design is based on the use of currently available components; and the manufacturer is committed to complete the product design, including the development of specific adequate maintenance procedures and providing continuing product support.

Online. Actively engaged in NADIN operational functions for use by the operational system.

Online Maintenance. Maintenance of elements during periods when the elements are actively engaged in NADIN operational functions, or under the control of the online system (see Section 3.5.3.2.1).

Online Maintenance Programs. Maintenance performed by the operational program which includes routines to maintain and report on current element status, detect errors, and diagnose and print out limited information on errors (see Section 3.6.3.3.1).

Operational Program Component. See Section 3.5.3.

Preventive Maintenance. Planned periodic marginal and functional testing of elements and components (e.g., checking for out-of-tolerance components, checking for misalignment of tape head).

Routine Maintenance. The regular repair of failed components at the test bench and regular repair and maintenance of electromechanical devices (e.g., cleaning and adjusting magnetic tape heads).

Scheduled Maintenance. Planned maintenance, which includes preventive, routine, and corrective maintenance.

Station. Same as terminal.

Support Program Component. See Section 3.5.4.4.

System Performance Analysis Programs. Deleted.

Terminal. A device that operates on a NADIN circuit or identified NADIN interface over which data (messages or control information) is exchanged. Essentially, all elements other than NADIN nodes are terminals.

Unscheduled Maintenance. Maintenance required immediately following a failure found by the online maintenance function which cannot be scheduled for a later time (e.g., total system failure, or an element failure where no further element of that type is available for use by the operational system).

Utility Programs. See Sections 3.5.4.1 and 3.5.4.2.

3.3 System Requirements and Configuration

The NADIN system shall be an integrated digital communications system providing a range of communication services, as described herein, that presently are serviced by separate FAA networks. Furthermore, the NADIN system shall be capable of modular expansion to meet future growth in existing services as well as to provide the capability for accommodating new services and functions as specified in Section 3.4.1.1. The NADIN system shall consist of data switches, concentrators, and the associated communications equipment and facilities required to interconnect switches, concentrators, subscriber terminals, and other networks as subsequently specified in this paragraph. The NADIN

switch equipment includes digital computing elements, memory element, input/output elements, and adapter units to provide the interface to computer-oriented peripheral devices, selected subscriber circuits, and remote concentrators. The network must exhibit extremely high reliability to provide continuous 24 hour per day operation 7 days a week. The system shall have expansion capability to meet anticipated increases of air traffic control data, high level network operation and shall be of efficient and economical design that will assure continuity to the operation. The NADIN system shall be:

a. Based on off-the-shelf components with only such modifications or custom features as are necessary to perform the functions that are detailed in this specification.

b. Readily expandable to meet changing needs with a minimum of reprogramming and no over-all system downtime.

c. Controlled by operating system programs, which assign tasks in a planned manner embodying the automatic reassignment of elements under failure conditions, so that no single element is critical to the operation of the system.

d. Highly reliable and easily maintainable, monitoring its elements and detecting its failures.

e. Provided with sufficient memory, arithmetic and control, and input/output elements in an online status so that individual element failures will not result in node failures.

f. Designed to minimize programming, training, maintenance and logistic support in quantity and personnel skill levels required for implementation and operation.

g. In conformance with certain minimum hardware functions that are separately stated in this specification.

3.3.1 System Network Configuration

The NADIN configuration (see Figure 3.3-1) shall consist of:

a. Two switching nodes geographically separated within the conterminous U.S. (CONUS), and interconnected via two 9600 b/s dedicated synchronous communications circuits, and two 4800 b/s dial back up synchronous communications circuits.

b. Twenty-three concentrator nodes, located at each ARTCC (except Balboa) within the FAA jurisdiction, i.e., all twenty ARTCCs within the CONUS and the ARTCCs at Honolulu, Anchorage, and San Juan. Concentrators shall connect to the data switches over point-to-point 9600 b/s dedicated synchronous communication circuits and 4800 b/s dial backup circuit. Each switch shall control approximately one-half the total number of concentrators located within NADIN.

c. Links connecting terminals with concentrators, of the following types:

1. Low-speed, 50 to 300 b/s asynchronous teletypewriter communication circuits.

2. Synchronous and asynchronous medium-speed circuits.

3. High-speed, byte-serial computer circuits, connecting concentrators to the NAS 9020 computers.

d. Multiple low- or medium-speed communication circuits to international centers of the ICAO network (AFTN).

1. Low-speed, 50 to 300 b/s asynchronous teletypewriter communication circuits.

2. Synchronous and asynchronous medium-speed circuits.

e. Two medium-speed synchronous communication circuits connecting the NADIN switching centers to the Weather Message Switching Center (WMSC) located in Kansas City.

f. Medium-speed circuits to the automated flow control processor facility collocated with the Jacksonville ARTCC.

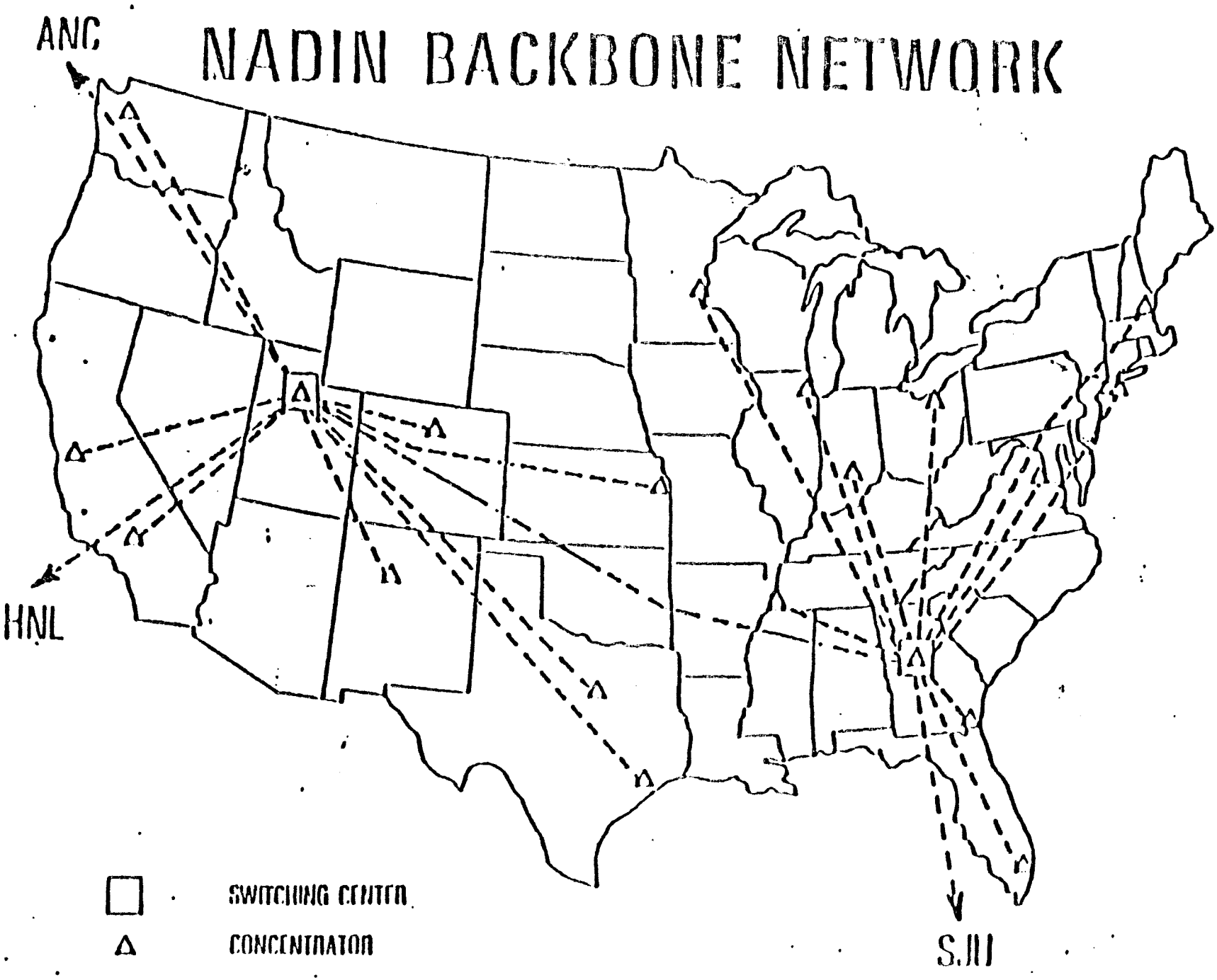
g. Deleted.

h. Medium-speed asynchronous and synchronous circuits to Flight Service Automation facilities that exist or are planned at the time of NADIN implementation.

i. Medium-speed synchronous circuits to Air Carrier Communication Systems for automatic exchange of flight data.

j. Medium-speed synchronous circuits to the National Weather Service processor.

FIGURE 3.3-1


NADIN BACKBONE NETWORK
ANC
HNL
S.JU
SWITCHING CENTER
CONCENTRATOR

k. Training and developmental concentrators. During normal operation, with two switches and 23 concentrators connected and operating, it shall be possible to connect and operate through the direct dial system to either switch up to three additional concentrators which will be used for training and for new or modified interface development and testing. During periods of degraded performance it shall be permissible for the switch to semi-automatically disconnect any training or developmental concentrator which is connected to the switch.

l. Medium-speed asynchronous circuit to the Air Force switching center at Carswell Air Force Base.

m. Medium-speed synchronous circuit to the NFDC/(CNS) processor.

n. Medium-speed synchronous circuit to the Flight Data Input/Output system.

o. Medium-speed synchronous circuit to ARINC and to the Eastern Airlines system one.

This configuration provides an integrated network for all current ATC teletypewriter subsystems and networks, and is referred to as NADIN. The implementation of NADIN will thus provide the baseline system for additional integration of data services requiring substantially larger traffic volumes, faster response time requirements, and additional interfaces. Interface terminations for the concentrators and switches are specified in detail in the appendices.

3.3.2 NADIN System and Network Capabilities

The system shall be capable of:

a. Transferring all messages presently being handled by the FAA Service B network (Area, Supplemental, Utility B, Center B, and NASNET).

b. Transferring all messages presently being handled by the FAA controlled portion of AFTN, to be referred to herein as the National AFTN.

c. Interfacing and communicating with, but not limited to, the Weather Message Switching Center (WMSC), Direct Access Radar Channel (DARC), Aviation Weather and NOTAM System (AWANS), Central Flow Control, Air Carrier Communication Systems, National Weather Service (NWS) at Suitland, Meteorological and Aeronautical Presentation System (MAPS), the International Aeronautical Fixed Telecommunications Network (AFTN), the Air Force switching center (Carswell), the NFDC/CNS, the FDIO system, and the Flight Service Automation System.

d. Readily implementing hardware and software functions to handle all projected traffic volumes and data services.

e. Throughput and delay factors within the limits stated within this specification.

f. Highly reliable operation, with easily maintained components as further defined witnin this specification.

g. Monitoring its elements and detecting its failures, and automatically responding to its failures.

h. Online monitoring and recording of operational data that will provide information on system throughput, message volumes, message distribution, status of nodes, links, and queueing delays.

3.3.2.1 Switch-to-Switch Communications

Initially, the switching centers shall be connected via two 9600 b/s leased communication circuits. Each switch shall have the capability of semiautomatically calling the other switch over a dial-up switched network in case of primary circuit failure. Primary circuits shall be capable of being served by both digital and analog leased data circuits (see Sections 3.4.8.6.1.10, 3.4.8.6.1.16 and Appendix R).

3.3.2.2 Data Flow and Message Handling

The switching centers shall control all data flow throughout the network, except that under normal operation the concentrator will provide local switching of messages between FDIO terminals and NAS 9020 computers. Data flow between terminals shall be via the appropriate concentrators and switching centers with all routing and accountability (except as noted above for NAS 9020-FDIO local traffic) being handled by the switching centers. Messages handled by the network shall have the option by circuit to be converted to the basic NADIN format upon input to the concentrator, or at the switching center. Provision must be made at the switching center to ensure that all messages routed to international AFTN locations are in conformance with Annex 10, message handling requirements, to the extent specified in this specification and in accordance with applicable provisions of ICAO DOC 8259.

3.3.2.2.1 Functional Division. The functions of the switching centers are divided into two parts: one that is concerned with the transfer of messages between switching centers and one that is concerned with the transfer of messages to concentrators and terminals of the network and to tributary networks.

3.3.2.2.1.1 High Level Transfer. The transfer of messages between switching centers is considered the high level portion of the network and shall be as specified herein.

3.3.2.2.1.2 Intranetwork Transfer. The transfer of messages within the network, and to tributary networks shall be handled by the switching center software except for the limited local switching for NAS 9020-FDIO traffic. This software shall be modular in design to allow the addition and deletion of network and tributary interfaces without redesign.

3.3.2.2.1.3 Information and Control Messages. The network shall be capable of handling two basic types of messages on circuits between switching centers, and between switching centers and concentrators. User messages are handled throughout the network and are referred to herein as information messages. Messages required for network control purposes (i.e., circuit/channel status, automatic test messages, etc.) are referred to as network control messages.

3.3.2.2.2 Overflow Handling Requirements. In unusual circumstances when the instantaneous traffic load is too large to process, during extended circuit outages, or during an extended terminal outage, it will be necessary to protect against overflow conditions. Each NADIN switching center, automatically, and by command from the system operator, shall be able to throttle input, move queues and messages from primary mass storage to secondary mass storage, and take other appropriate action as necessary based on the contractor's design. The contractor shall describe the approach he proposes to preclude these conditions, (i.e., overloads, circuit or terminal outages, etc.) what actions he proposes to take under these conditions, and all operator notifications and resulting operator actions.

3.3.2.2.2.1 Overflow Queue Handling. Each of the two NADIN switching centers shall have the capability via a supervisory console operator input, to cause accountable messages in queue to be removed from the "online" system and transferred to removable secondary mass storage. This process shall be selectable by station and by transmission priority level. Messages which are classed as unaccountable shall be removed from the "online" system, (i.e., active elements) and discarded. Upon command by the supervisory console operator, the NADIN switch shall read the accountable messages from secondary mass storage back into the "online" system and process them for transmission. These messages will be placed at the bottom of the message queue.

3.3.2.2.3 Message Processing. The switching center provides the majority of message processing functions required within NADIN. These functions shall include, but not be limited to, the following:

a. Message buffering
b. Code and format conversion as required
c. Message routing
d. Message journalling
e. Queueing of messages for output to concentrators
f. Operational data collection, analysis, and statistical report generation
g. Maintaining online and 30-day storage as required
h. Message preparation and buffering for high level link operation
i. Queueing of messages for output to other networks or hosts
j. Format control and edit
k. Message accountability
l. Network management

3.3.2.2.3.1 Format Control and Edit. An automatic intercept and error correction function shall be provided to correct certain types of format errors. The intercept operator shall have the capability to display and attempt manual correction of errors not

corrected automatically. The switch shall service and address the intercepted message to either the originator or system intercept. The automatic format error correction capability shall include the detection and processing of messages without start of message (SOM) sequences and/or end of message (EOM) sequences.

3.3.2.2.3.2 Address Verification and Restrictions. The NADIN switch shall have the capability to determine that the origin station and destination addresses, for which NADIN has final delivery responsibility, are valid. Also, the switch shall be capable of examining incoming addresses and preclude delivery to specific addresses and groups of addresses (including collective addresses), based on the origin station. The intent of this requirement is to accept messages only from authorized locations, to restrict acceptance of messages having wide distribution patterns, and to restrict delivery to authorized network terminals, including the restriction of one class of terminal communicating with another. Example: Military BASOPS have no requirements to communicate with Air Carrier Dispatch Offices, even though both are valid network terminals. Messages received that violate routing restrictions shall be treated as edit failures. When input is received with a diversion indicator, NADIN will only be responsible for the first line of addresses.

3.3.2.2.3.3 Code and Format Conversion. When messages are received from other networks external to NADIN, the receiving switch shall perform code and format conversion as required to be NADIN compatible. Messages received from within the NADIN network destined to terminals within the NADIN network shall be converted to the appropriate code and format as determined by the NADIN destination output circuit. Format conversion for locally switched traffic between FDIO and the NAS 9020 shall be provided by the NADIN concentrator to insure compatible communications format, e.g. correct End of Line (EOL) Sequence, End of Transmission (EOT) sequence, etc. The code and format of messages destined to other networks shall be converted as required.

Three (3) and Four (4) Character Addresses

(A) NADIN software will modify received three character addresses for routing and output delivery by adding K in front of the address and following the sequence with YF (i.e., - KXXXYF).

(B) If the received address contains four (4) alpha characters, NADIN will add YF to the address prior to message routing and output delivery.

3.3.2.2.3.4 Intercept Functions. Refer to Appendix SS as the governing document for console functions, positions, designs, and locations. If the NADIN switch detects an invalid, illegal or unidentifiable message format or message address that relaxed editing procedures cannot correct, the switch shall service and address the intercepted message to either the originator or system intercept. Intercept shall be selectable by input line and station. Any communication envelope format errors (i.e., missing or invalid address, missing or invalid STX, missing or invalid EOM, etc.) in messages from the NAS 9020 computer detected by NADIN shall be errored and routed to the originating NAS 9020. For NADIN to NAS 9020 computer message transfer NADIN shall ensure the NAS 9020 receives the EOL sequence preceding ETX by inserting EOL before ETX. The NADIN switch shall assume no routing responsibility for messages intercepted and returned to the message originator, except for SS messages intercepted. Undeliverable SS messages should be queued ahead of lower priority messages and behind other SS messages queued at the edit position (SS messages should never be rejected back to the originator) (see Section 3.3.2.2.8.2). Messages intercepted and delivered to the intercept position shall be routed following reentry. From the system intercept functional position, the NADIN switch shall be able to accept a corrected version of the message and process the corrected messages as if it were received through a normal line input. In addition, the NADIN switch shall journal the intercept event and reentry of the message.

3.3.2.2.3.5 System Intercept Position. Refer to Appendix SS as the governing document for console functions, positions, designs, and locations. The NADIN system intercept position shall be one or more addressed terminals collocated with a NADIN switch. It shall be capable of receiving intercepted messages from the NADIN switch, displaying the messages to an operator, accepting operator corrections to the intercepted message and, upon operator command, reentering the message into the NADIN system. The NADIN system intercept position shall provide selectable hard copy of all messages delivered to the terminal and all messages entered from the terminal. It shall also be capable of functioning as an entry device for originating messages into the NADIN system. The NADIN intercept system shall be capable of processing up to two percent of the peak hourly rate of messages entering the network (see Appendix Z). The intercept positions shall be modularly organized so as to permit cost-effective utilization of Government operators as the intercept message load fluctuates.

3.3.2.2.3.5.1 System Intercept Position Configuration. Refer to Appendis SS as the governing document for console functions, positions, designs, and locations. The NADIN system intercept position shall use programmable, intelligent KVDU terminals operating in ASCII code. Each terminal's capabilities shall include: display of all ASCII characters including communications control and device control characters; unique display of non-printing characters; display of the reason for intercept provided by the switch, possibly by flagging the first error discovered; forward and backward line-by-line scrolling; cursor control (left, right, up, down), edit functions (clear, insert character, delete character, insert line, delete line, etc.), direct retransmission of messages; automatic generation of the intercept service header upon reentry. Also, each terminal shall be capable of processing a maximum message length of 3700 characters. The contractor shall deliver a minimum of 25 percent additional executable memory above that actually used.

The KVDU terminal shall be capable of displaying all 128 ASCII characters in a 24 line, 80 character per line format. The characters displayed shall use at least a 7 x 9 dot matrix. The display screen shall measure at least fifteen (15) inches on the diagonal and shall have a non-glare surface. The brightness shall be sufficient to allow the display to be read easily from a distance of three (3) feet with ambient light of 70 ft. candles. The terminal shall be equipped with a keyboard capable of generating all 128 ASCII characters, and shall follow the normal ASCII arrangement for the alphabetic and numeric keys. Suitable keys shall be provided for cursor control and control of edit functions. It shall be possible from the intercept position to cause a printout to be made of the displayed message.

3.3.2.2.3.6 Message Distribution. The NADIN switch shall distribute messages to a concentrator or terminal (or switch in the case of switch-switch transmission) so that only the selected concentrator or terminal receives the message transmitted.

3.3.2.2.3.7 Routing Requirements. The NADIN switch shall determine the correct routing for each individual message with the exception of those FDIO and NAS 9020 originated messages locally switched by the NADIN concentrator. A routing program is required to convert system 3, 4, 6, and 8 character addresses to absolute routing parameters. The NADIN switch shall be capable of performing address translation to determine the destinations of the message by line, concentrator, and terminal address. The following types of routing shall be accommodated:

a. Explicit address: Single or multiple explicit addresses, each one identifying a specific addressee.

b. Collective or group address: Each address may represent one or more explicit addresses. However, the result shall not exceed 512 explicit addresses per message.

c. Implied routing: In addition to the specified addresses, the message shall be routed to one or more additional addresses up to a maximum of eight additional addresses. The implied routing criteria shall be input station and input line.

d. Alternate routing: Instead of routing the message to the stated address, route the message to an alternate address but keep the original address in the message header.

e. Exception routing: Deleted.

f. Internal routing: Routing messages to internal nodal or system functions, e.g., intercept supervisor, traffic retrieval, maintenance reports and similar functions, shall be accomplished by any of the above addressing or routing methods, initialized by table-build statements, modifiable by table change, subject to equipment configuration constraints.

g. NAS 9020 service messages: The SSU and SSD messages shall be automatically routed by their address to the NADIN switch supervisory position.

h. Service messages other than SSTs from the NAS 9020 which are addressed to the message switch shall be automatically routed to the NADIN switch supervisory position for manual action.

The contractor shall design the routing program and directory to accommodate future changes to the definition of the 5th, 6th, 7th, and 8th characters of ICAO addresses, e.g.,; 5th, 6th, and 7th characters become designators for operating agencies, aeronautical authorities, etc., with a single 8th character used for internal routing within an office, or the use of a 9th character for retaining the current internal routing assignments. This capability must be modular and easily implemented.

3.3.2.2.3.8 Routing Table Changes. Routing tables necessary to perform normal routing functions shall have the capability of being modified online by adding, removing, or modifying their contents to add, change, or delete destinations to eliminate the impact of system configuration changes on an

operational program. All such changes shall produce a printed copy to the switching center system console operating personnel. Furthermore, such changes shall be permanently recorded, so as to be active after a system recovery. These changes shall be subject to constraints imposed by any online configuration control requirements. Changes to configuration control shall not be intermixed with each other, nor with routing. At the time of implementation of an online routing change, all traffic already in queue shall be processed without regard to the routing change, except for alternate routing changes which shall affect all traffic, but not messages in the process of transmission.

3.3.2.2.3.9 Routing Line Segregation. The NADIN switch shall be capable of segregating action addresses by emanating message switch or concentrator circuit as appropriate so that only addresses destined for that emanating circuit appear in the message header for that circuit. This process is also known as address stripping.

3.3.2.2.3.10 Automatic Alternate Routing. The NADIN switch shall have the capability to automatically route messages to an alternate address instead of the stated address, while maintaining the original address in the message header. Routing tables necessary to perform automatic alternate routing shall have the capability of being modified online by adding, removing or modifying their contents to add, change, or delete queues to eliminate the impact of system configuration changes on an operational program. All such changes shall produce a printed copy to the switching center system console operating personnel. Furthermore, such changes shall be permanently recorded, so as to be active after a system recovery. At the time of implementation of an online change to the automatic alternate routing table, all messages in queue shall be processed without regard to the change until the appointed time (but not messages in the process of transmission) and on a message boundary. The message switch shall perform the following functions:

a. Automatic alternate routing capability of any queues to another terminal using predetermined times and locations.

b. Advise supervisory position through printout whenever automatic alternate routing has been completed.

c. Capability to check hourly for additional locations to be automatically alternate routed and return of any locations that have been previously automatically alternate routed.

d. Restoration of all locations automatically alternate routed or due to be automatically alternate routed when there has been a system failure or restart.

e. Not allow automatic alternate routing when manual alternate routing is in progress.

f. Allow manual cancellation of automatic alternate routing when in progress.

g. Allow all circuit broadcast messages to be transmitted even though terminals have been placed in an automatic alternate route status.

h. Allow group address messages to a multidrop circuit to be transmitted to the appropriate alternate addressee in the case where some of the stations on the circuit are in the alternate route mode.

3.3.2.2.4 Message Processing Functions. When a message is received, the switch shall determine accountability requirements based on the criteria stated in this specification (see Section 3.3.2.2.7.4). For those messages requiring accountability, the switch shall store the message on secondary storage. All locally switched traffic (i.e., switched by the input concentrator) is unaccountable. For messages not requiring accountability, secondary storage protection is not required provided the contractor complies with the other requirements of this specification, e.g., link control protocols, address restriction, journalling, and traffic analysis. The message response to a terminal shall be optional by circuit. The message switch shall perform the following functions:

a. Records the message as appropriate for journal and retrieval requirements.

b. Provides all required code and format conversions.

c. Examines destination addresses and routes the message based on these addresses.

d. Queues the outgoing message first-in first-out by internal priority for subsequent distribution (see Section 3.3.2.2.8).

e. Communicates with the concentrator and other nodes to establish message transfer.

f. Queues all messages to the baseline circuit of a group of circuits in rotary. Distribution from a rotary base shall be by one of two methods both selectable by table-build statement:

(1) Fully cooperative - selection of the first available circuit from the baseline circuit, or

(2) Equal load sharing - selection of the first available circuit from the last circuit selected.

g. NADIN shall automatically respond to the SST service message sent by the NAS 9020 computer with a SST service message.

3.3.2.2.5 Message Distribution. The system shall forward the message according to the link protocol, format, and code prescribed for the outgoing circuit. On circuits connecting the switch to a concentrator, the switch shall forward a message on a frame by frame basis. The concentrator shall accept the outgoing message on a frame by frame basis (see Section 3.3.2.10.5) and

a. Provide error checking and acknowledgement upon receipt of each frame.

b. Call the destination terminal, except in the case of traffic to the NAS 9020 computer, following the receipt by the concentrator of the first message frame of the message from the switch. For messages to the NAS 9020 computer, the NADIN concentrator shall call the destination following receipt by the concentrator of the End of Message from the switch.

c. Forward the message to the destination terminal in the correct code, format, and protocol on a frame by frame basis.

3.3.2.2.6 Message Delay. NADIN shall satisfy the delay requirements as specified in Appendix Z.

a. The message accountability response from the message switch shall arrive at the concentrator within 2 seconds after terminal message transmission is completed.

b. The delay between successive waiting frames on a synchronous circuit shall not exceed three character intervals.

c. The delay between successive blocks (or between characters of a reassembled message) on an asynchronous circuit shall not exceed one character interval.

d. The delay between successive messages, blocks, or frames on other circuits external to NADIN shall be covered by the appropriate Interface Control Document contained in the appendices of this specification. Appendix Z specifies expected traffic characteristics and volumes to be supported by NADIN, defines system performance requirements in terms of throughput and delay, and specifies communication terminations required at concentrators and switches.

3.3.2.2.7 Message Accountability Requirements. As a minimum, message accountability shall be provided in accordance with the following guidance.

3.3.2.2.7.1 Message Numbering Requirements. The NADIN switch shall number all messages both accountable and unaccountable (with the exception of concentrator switched NAS 9020-FDIO messages and the exception of NADIN response messages) to each subscriber. Individual numbering sequences shall be kept for each subscriber input and output. After a terminal has transmitted a message into the system, the switch shall assign and notify the terminal (if circuit is so classmarked) of the assigned sequence number. The switch shall assign message priority level two to the response message to ensure immediate delivery of the sequence number to the terminal. Message number sequencing by subscriber shall be a table build parameter, its use optional by emanating switch circuit or concentrator circuit.

3.3.2.2.7.2 Node Accountability Requirements. The NADIN switch shall be responsible for the proper accounting of incoming messages and shall inform the originating terminal or interfaces of any accounting discrepancies.

3.3.2.2.7.3 Incomplete Messages. The NADIN switch shall notify the transmitting concentrator or switch of any transmission and logical errors which occur during the message exchange. However, if a message text is incomplete but there is complete heading information, the switch shall forward the received portion of the message as directed by the header. New endings shall be added by NADIN in accordance with ICAO Annex 10, Volume II. Traffic addressed to the NAS 9020 and perceived as incomplete by NADIN will be delivered to the destination NAS 9020 DTE position, with the check text, new ending added, for handling by the destination addressee except for missing EOL prior to ETX which is handled in accordance with Section 3.3.2.2.3.4. When an incomplete message from the NAS 9020 is received by the NADIN concentrator it shall be delivered to the originating NAS 9020 computer.

3.3.2.2.7.4 Unaccountable Messages. The switch shall have the capability to determine if a message is accountable or unaccountable based on incoming circuit and input station. Messages that are unaccountable do not require recovery as a result of node and circuit failures, and shall not be retrievable from the switching centers even during normal operations. These messages are accountable by the end-to-end users and are recovered and protected against loss by procedures outside of NADIN (see Sections 3.3.2.3.3 and 3.3.2.2.2.1). All message traffic from the NAS 9020 to NADIN will be classified as unaccountable.

3.3.2.2.8 Message Priority. The switch shall process information messages based on an internal four level priority structure. NADIN does not change message priority. Level 1 shall be the highest level for message processing.

Information Message Priority	Internal Priority
SS	Level 1
DD	Level 2
FF	Level 3
GG	Level 4
JJ	Level 4
KK	Level 4
LL	Level 4

3.3.2.2.8.1 Link Priority. Circuits between switching centers, and between switching centers and concentrators shall employ a two-level link priority system. All information messages except level 1 will be assigned a low-link priority. Level 1 shall be assigned a high-link priority. Network management messages shall be assigned high or low priority based on function, but will have precedence for transmission over information messages of the same link priority.

3.3.2.2.8.2 SS Priority Messages. All messages having a priority of SS shall be queued ahead of lower priority messages after existing SS messages, and routed to the destinations without delay. Each SS priority message shall also be delivered to the supervisory console printer for any manual functions.

The editing functions for SS messages shall be relaxed so that the only criteria for forwarding is a complete "valid" address ending in EOA. These SS priority messages procedures supercede general message handling procedures described elsewhere in the specification.

3.3.2.3 Message Retrieval

The NADIN switch shall have an automatic capability (i.e., no manual intervention required for NORMAL online retrieval operation) to identify, process, retrieve, and retransmit messages identified in a user's retrieval service request. This retrieval capability shall not apply for those messages that are unaccountable in the NADIN. The request shall contain one of the following options:

a. A specific station message output sequence number.
b. All messages inclusive between two output station sequence numbers.
c. All messages inclusive between two intervals of time by output circuit and by output station.

All retrieval requests shall be limited to a maximum of 10 messages whether the request is by sequence number or time parameters. A sequence number retrieval request with a range exceeding ten (10) shall be rejected as invalid. A time range request shall result in the first ten messages in the time frame being retrieved if more than ten are present in the interval.

3.3.2.3.1 Retrieval Storage. The switch shall have the capacity to provide fully automatic, online retrieval of the peak six hours of message traffic. Retrieval must be provided for 30 days of traffic on a removable, mass storage device (e.g., magnetic tape or disk). The retrieval of offline stored messages shall be performed online once the proper files are made available. The contractor shall provide the methodology to include identification of offline files and protection against erroneous file purging (see Section 3.3.6).

3.3.2.3.2 Retrieval Response Time. Once the file is available to the online system, the total elapsed response time (from reception of the retrieval request to queueing of the retrieved message) shall not exceed five minutes under peak hour traffic load at an input rate of 30 retrieval requests per hour. The system shall be capable of accepting a series of retrieval requests and queueing them for processing.

3.3.2.3.3 Retrieval Responsibility. The NADIN switch shall have the capability to determine which messages are to be recorded for possible retrieval and which are not (i.e., accountable vs. unaccountable), based on the parameters specified in Section 3.3.2.2.7.4. Therefore, messages may be nonretrievable because of several reasons:

a. Network accountability not required, therefore no record copy is available.

b. Retrieval file is purged, unreadable, etc.

c. Requesting terminal was not an addressee for the message. Exception: switch center operation positions shall be able to retrieve any accountable messages.

If no retrieval is possible, the switch shall respond to the user's request for message retrieval indicating that message retrieval was unsuccessful. A copy of this message shall be supplied to the supervisory retrieval position at the switch.

3.3.2.3.4 Retrieval Request Message Format. All retrieval requests shall be single addressed messages, the address being the appropriate 8 character addresses assigned for automatic retrieval processing. The first three characters of the text field shall contain the characters RET to indicate retrieval request. Messages returned to terminals as a result of retrieval by output parameters shall be labeled as duplicate messages by insertion of the characters "DUPE" (except for circuits that have the dupe inhibit class mark) as required by ICAO Annex 10 for Baudot circuit output (for IA5 circuit, NADIN will insert "DUPE (CR) (LF) (VT) (ETX)"). In particular, the inhibit classmark is in effect for NADIN to NAS 9020 messages.

Responses to retrieval requests shall be returned with the same priority as that of the message being retrieved. Retrieved messages of SS priority shall not be delivered to the supervisory console printer unless the supervisor was the originator of the retrieval request.

3.3.2.4 Journalling Requirements

The contractor shall provide equipment and methods to collect, organize and record data required for online and offline functions of Sections 3.3.2.4.1 and 3.3.2.6 of this specification. Each message transiting a switch, including those messages for which the switch does not provide accountability and retrieval, shall have the event recorded. In addition, sufficient journal information shall be forwarded to the switch by the concentrators to ensure that the analyses specified in Section 3.3.2.6.5.4 can be carried out.

3.3.2.4.1 Message Journalling. As a minimum, the following information shall be recorded for all traffic transiting a switch:

a. All data contained between SOH and STX, formatted for storage for ease of access to discrete significant data elements in the header.

b. Deleted

c. Number of characters or octets in message text.

d. Number of characters in message header.

e. Date time of receipt by message switch (month, date, hour, and minute).

f. Date time of transmission by message switch (month, date, hour, and minute).

g. Input station and serial number, if applicable (see Section 3.3.2.2.7.1).

h. Output station and serial number, if applicable (see Section 3.3.2.2.7.1).

i. Identification of the switch and concentrator channel on which the message was received and that on which it was sent.

j. Identification of NADIN inter-switch trunk transfer.

k. Disposition of message, (e.g., transmitted normally, intercepted, overflow, returned to origin).

l. Response to retrieval requests.

3.3.2.4.2 Associated Data Journalling. The following data shall be journalled with each message recorded per the requirements of Section 3.3.2.4.1, as appropriate:

a. Number of message frames received by the switch.

b. Number of message frames transmitted by the switch.

c. Date time, duration, I/O port number (concentrator or switch), and calling station for messages from dial up terminals.

d. (Requirement deleted with dropping of FOT.)

e. Number of chargeable units. If message is to receive billing analysis, a chargeable unit is to be determined by dividing message character count by six.

f. Number of network control messages received by a switch.

g. Number of network control messages transmitted by a switch.

h. Reports, commands and alarms.

3.3.2.4.3 Permanent Recording of Journal Information. Permanent recording of journal information shall be on a removable secondary storage device, (i.e., magnetic tape, disk, etc.) organized by 24-hour clock designation. Nothing in this section shall preclude the contractor from deriving this information from other online files and subsequently recording it on the removable secondary storage device at appropriate intervals. The contractor shall supply sufficient removable secondary storage to store offline ten days of journal information.

3.3.2.5 Supervisor Functions

Refer to Appendix SS as the governing document for console functions, positions, designs, and locations. There shall be several functions which require communications between the NADIN switch and operators, maintenance, and programming personnel. All functions required to effectively manage the switch and network, control and operate the equipment, control the flow of traffic, diagnose and correct equipment or software malfunctions, and to permanently record designated events, commands, responses, and actions shall be included as supervisory functions. These functions shall be exercised from system consoles at both switching centers. These functions shall include, but are not limited to, the following:

a. Traffic intercept
b. Traffic services
c. Computer operations
d. Maintenance notifications
e. Programming notifications
f. Switch supervision
g. Traffic supervision
h. Reports, alarms, commands

3.3.2.5.1 Supervisory Configuration. The switch design shall permit any of the above functions to occur at any position under configuration control. The configuration control shall be under dynamic control of the switch supervisor. The contractor shall develop a normal operating configuration that shall logically group the above functions. The configuration shall take into account anticipated activity, operational concept, and economic minimization of equipment and manpower. If there are any constraints that would limit or prohibit the reconfiguration of these functions, the dynamic allocation of these functions or combinations thereof, or the electrical or logical interchange of the provided equipment(s), the contractor must state the nature of these limitations.

3.3.2.5.2 Reports, Commands, and Alarms. The contractor shall provide a repertoire of supervisory reports, commands, and alarms. This repertoire shall be described in a suitable manual that contains the meaning, priority, acknowledgement (depending on execution status), format, and operator actions (required or recommended) as appropriate for each node command and alarm. This repertoire shall include but not necessarily be limited to those reports, alarms, and commands outlined in Appendix K.

3.3.2.5.3 Access Restrictions. The contractor shall specifically provide a method of logically inhibiting access to certain commands from all positions except those so designated by configuration control. Even in the allowable position(s), access shall be logically limited. Examples of commands that fall into access restrictions are:

a. Altering core locations or disk locations
b. Activating patches, directory changes
c. Shutting the system down
d. Activating diagnostics

3.3.2.5.4 Circuit Monitoring. The contractor shall provide a method of monitoring the status of all NADIN backbone circuits. This monitoring function shall not hinder the performance of the system. If any performance degradation occurs, notification shall be given to the switching center. Further the system shall output a status report to the supervisor, listing the user circuit status, whenever the capability for NADIN to deliver or receive message traffic is lost.

3.3.2.6 Offline Statistical Analysis

The offline analysis functions described in this section shall utilize raw data contained on the journal record described in Sections 3.3.2.4 and 3.3.2.6.5.4 of this specification, and operate independently at each switch center. The contractor shall provide programs to analyze the recorded raw data as defined in this specification. Each function shall be initiated by input commands (e.g., console keyboard input, card input) to be specified by the contractor. A means of specifying default values for input commands shall be provided. Results of the analysis shall produce hard copy output at the supervisory console or the line printer, by optional command. The contractor shall identify and provide for any additional functions for statistical analysis, and illustrate the utility of these additional functions, necessary for the contractor's design approach. The paragraphs of this section shall not determine the required software organizational structure, e.g., whether one program or multiple programs will be necessary. The contractor shall determine the structure and shall demonstrate the adequacy and efficiency of the structure to meet the requirements of this paragraph.

3.3.2.6.1 Message Intercept Analysis. This function shall report values for each of the following: aggregate number of messages transmitted by the NADIN element under analyis, the percentage of the aggregate in each reportable intercept category (see Section 3.3.2.2.3.4) and the percentage of the aggregate returned to the NADIN element under analysis. It shall be possible to obtain reported values for the NADIN element under analysis, i.e., for a specific terminal, for all terminals on a specific circuit of a concentrator, for all terminals associated with a specified concentrator, for all terminals associated with a switch, and for any desired grouping of terminals.

3.3.2.6.2 Billing Analysis. The function shall report values for each of the following: aggregate number of messages analyzed, the aggregate number of chargeable characters in those messages, and the cost charges for the message (aggregate number of characters times the associated cost charge) per each billing account. Each input terminal shall be billed to only one billing account. Messages from terminals without billing accounts shall be charged to a single default account designated for that purpose. A maximum of 127 billing accounts shall be allowed with a maximum of 8 terminals per account. Applicable taxes shall not be included in the billing analysis. The aggregate number of messages analyzed and the aggregate number of chargeable characters shall only include those messages for which there is a charge. All messages with KK or LL priority from a chargeable terminal shall have a charge. Messages of all other priorities shall not have a charge. In case of multiple deliveries for a message input from a terminal, each message delivered shall be included in the aggregate number of messages. The aggregate of the messages analyzed shall include each message successfully delivered to the intended terminal or

network exit interface. Element 4 of Additional Data Field (optional subfield A) shall not be used to determine billing. Charges shall be computable by two methods, each having its own control parameters:

a. Utilizing message priority and associated cost (reference FAR 189).
b. Deleted.
c. Utilizing originating station and associated cost.

It shall be possible to obtain report values for a specific terminal, for all terminals for a specific account, and for any desired group of accounts.

3.3.2.6.3 Dial-Up Circuit Analysis. This function shall report values for the aggregate number of calls, and the total duration of calls. It shall be possible to obtain reported values for a specific dial-up port associated with a concentrator, for all dial-up ports associated with a concentrator, or to obtain values for all dial-up ports associated with a switch, and for any desired grouping of dial-up ports. The functions shall also report values for the following: date time of each call, the duration of the call, the originator identification, and destination identification.

3.3.2.6.4 (EX) Retransmitted Message Analysis. Deleted.

3.3.2.6.5 Traffic Analysis. The traffic analysis processing shall be capable of providing traffic information on a selectable terminal, circuit, concentrator, or switch basis, except for locally switched traffic (see Section 3.3.2.6.5.4). The period for which this information is calculated shall be as specified by the operator with at least the ability to obtain quarter-hour results. The traffic information shall include, for the specified period, at least the following:

a. Number of messages received, total, and by precedence category.

b. Similarly for number of messages sent.

c. Number of characters received.

d. Number of characters sent.

e. Count of messages by precedence category, and by message length, with reasonable upper and lower limits for each of at least 20 message length cells or brackets, and shall provide for a routine override of the limits provided.

3.3.2.6.5.1 (EX) Formats. Deleted.

3.3.2.6.5.2 (EX) Terminal Grouping. Deleted.

3.3.2.6.5.3 (EX) Journalling and Traffic Analysis Procedure Design. Deleted.

3.3.2.6.5.4 Traffic Analysis of Locally Switched Messages. The traffic analysis processing shall be capable of providing traffic information for locally switched traffic. Data for locally switched messages shall be provided for traffic between all pairs of locally switched stations (FDIO-NAS 9020) on each concentrator. In addition, both local and nonlocal traffic data shall be available. The local traffic information shall include gathering at least the following data to be processed off-line.

a. Number of messages sent per hour, by hour.

b. Similar information for messages received.

c. Deleted.

d. Deleted.

e. Deleted.

f. Deleted.

g. Deleted.

h. Deleted.

i. A count of the number of local messages required to be transmitted to the switch as a result of circuit contention with traffic from the switch or destination unavailability.

3.3.2.6.6 Hardware Configuration. All of the above analysis programs shall operate on the provided equipment, but may operate on offline equipment. The contractor shall state what equipment configuration is needed and the impact, if any, to the online systems.

3.3.2.7 NADIN Expansion Characteristics

NADIN shall be capable of expansion in a modular fashion, to accommodate the requirements specified in Appendix Z.

3.3.2.8 Terminal Operator Assistance

To maximize operator efficiency, the concentrators and switching centers shall provide a degree of assistance to a terminal operator.

a. Deleted

b. The switch shall provide the following features:

1. Message accountability (See 3.3.2.2.7.4).

2. Initiation of circuit continuity checks.

3. Initiation of network service messages as failure conditions require.

4. Service and intercept positions at each switching center.

5. Address verification (see Section 3.3.2.2.3.2).

3.3.2.9 Initialization and Recovery

As a minimum, the following initialization and recovery requirements shall be provided.

3.3.2.9.1 System Start-Up. The NADIN switch shall be supplied with self-loading operational programs that, upon operator initiation, will load the operational program from a removable secondary storage device, assume full control, initialize all communications circuits, devices, counters, etc., and initiate communications. The system start-up procedures from the time of operator initiation to the time external communications may be initiated shall not exceed 60 seconds. This time shall include loading of all programs, tables, and directories, and the printout of the system status at the supervisory position (see Section 3.5.3.1.5).

3.3.2.9.2 System Shutdown. The NADIN switch shall be capable of being shut down in an orderly manner under operator intervention. This procedure shall allow all traffic in transit to be processed as normal, but shall stop all polling and refuse acceptance of new traffic. Furthermore, notification to all terminals and concentrators of this process shall be automatic as the result of an operator command. Upon attaining zero queue status, a report shall be sent to the switch supervisors. Upon another operator command, polling and acceptance of traffic shall resume.

3.3.2.9.3 System Recovery Routines. System recovery shall be provided to permit the NADIN to regain normal operational capability after a period of degraded operation. The system recovery function shall assume control of the NADIN switch upon the initiation of system recovery by either automatic control procedures resident in the switch operating system or a manual entry from the supervisor's console. The system recovery shall determine all messages for which the NADIN switch has delivery responsibility, i.e., those that were undelivered or partially delivered at the time recovery was instituted. Upon restoral of message switching functions, the switch shall transmit (or retransmit in the case of partially delivered messages) all such messages. Normal system recovery shall restore input and output station serial numbers, cumulative traffic statistics, and other nontransient information such that the NADIN users are not required to take any local action to resume service. In the event that any message may be duplicated during this process, the message in question shall be labelled as a suspected duplicate message except for traffic to NAS 9020 or other circuit with the inhibit classmark. In those cases where recovery status information or the active responsible message file is nonretrievable or destroyed, the NADIN switch shall assume an initialized state and so notify all network users (also see Section 3.5.3.1.6).

3.3.2.9.4 Degraded Mode Recovery. System recovery shall also permit the NADIN to reconfigure into a reduced or degraded mode of operation when one or more hardware elements have failed and have been switched offline. The system's adjustments to establish such an operating mode shall be as automatic as feasible.

3.3.2.9.5 Switch Malfunction Detection. If conditions occur which cause error conditions in the switching functions of one of the NADIN switches, the other NADIN switch, in response to operator commands, shall be capable of assuming the load of the failed switch by semiautomatically dialing each of the failed switches' concentrators. Either NADIN switch shall be capable of assuming the traffic load and functions of the other NADIN switch as well as maintaining its own traffic load and functions within two minutes of receiving the network operator's command. The two minutes is predicated upon a first attempt successful dial connection to each of the other switching center's concentrators. The traffic load and performance requirements for this situation are defined in Appendix Z. Upon restoral of the failed NADIN message switching center and upon receiving an operator's command, the operating switching center shall relinquish control of the restored switching center's concentrators via an orderly transfer process that will include the transfer of input and output station sequence numbers and queued traffic. For a planned transfer of all the network functions from one switching center to the other switching center. the contractor shall provide for the transfer of queued traffic, input and output station sequence numbers, and other parameters in a logical manner to permit an orderly transfer. For a planned transfer of functions, the two minute transfer time is waived as a requirement. Ways of accomplishing a planned and unplanned transfer of functions shall be described by the contractor and the equipment and computer programs delivered shall be capable of meeting this requirement. The contractor shall assume that, for the duration, one message switching center is sustaining the traffic load of the entire NADIN network, the requirements stated in this specification as comprising the non-operational program component (i.e., traffic analysis, table-build, offline hardware and software maintenance) must still be met by the surviving message switching center (see Sections 3.4.2.2 and 3.5.3.2.1).

3.3.2.9.6 Abnormal System Conditions. The NADIN system shall be designed in such a way that the occurrence of a node or circuit failure causes little disruption in system operation, and that the network can recover rapidly from the effects of such a failure. The switches shall have the capability to detect failures and to take corrective action. In a given instance, it may be difficult to distinguish between a circuit failure and a node failure. The contractor shall submit a detailed plan of how he will support network operation during node and circuit failures as part of the hardware and software design data. The plan shall contain a detailed explanation of how circuit and node failures will be detected using the contractor's equipment and software.

3.3.2.10 Concentrator Message Handling

The concentrator shall be responsible for receiving incoming messages from terminals and other subscribers, e.g., processors and forwarding the messages to the switching center on a frame-by-frame basis or in the case of locally switched messages shall perform local routing (see Section 3.4.7.6.1). The concentrator shall have no secondary storage except for maintenance and diagnostic purposes (see Section 3.4.7.1 (i)). Training and development concentrators at Oklahoma City and Atlantic City shall operate under procedures in Section 3.3.2.10.9.

3.3.2.10.1 Concentrator-Data Switch Message Format. Unless otherwise stated, the message format used between the switch and the concentrator shall be the message format compatible with the originating or destination terminal. However, no constraint shall be placed on the concentrator that would preclude the concentrator from performing all message format conversions. It is mandatory that the concentrator architecture permit the modular expansion of message format conversion.

3.3.2.10.2 Concentrator Supplied Information. The concentrator shall supply the following components, for circuits so classmarked, of message formats when not supplied by the originating terminal:

a. Deleted.

b. Filing time - derived from real time that message was input.

c. Originator indicator - derived from poll call if multipoint, or fixed if point-to-point.

d. Deleted.

e. Deleted

f. Priority alarm sequence - for those circuits so class marked to have concentrator supplied information inserted, NADIN shall insert the priority alarm sequence immediately following the origin field in all messages containing a SS priority.

Combinations of these message format components shall be selectable by concentrator input circuit, via table-build statements. The contents within each of the above components except priority alarm sequence may vary by input station.

3.3.2.10.3 Address Indicators. Originator and destination address indicators shall be those in current use in the AFTN and Service B systems. However, combinations of three, four, six, and eight character addresses may be mixed in any message input to NADIN.

3.3.2.10.4 Message Transfer. The establishment and termination procedures to be used for information exchange between the switch and the concentrator as well as between the concentrator and the terminal shall be in accordance with the link control procedures as defined in Section 3.3.4 and as further defined within this specification.

3.3.2.10.5 Switch to Concentrator. Messages from a switch to a concentrator shall be transferred on a frame-by-frame basis. The concentrator shall perform all required interface functions before communicating with the selected output circuit to include, but not limited to, buffering, format conversion, speed conversion, code conversion, device control, and link control. Upon request by the switch, the concentrator shall send a network control message to the switch containing the message transfer status of all output circuits emanating from the respective concentrator.

3.3.2.10.6 Terminal to Concentrator. In general, messages being transferred to a terminal shall take precedence over messages being received from a terminal. The concentrator shall maintain a polling list for each multipoint terminal circuit. The polling lists may be weighted to accommodate the expected traffic from any one terminal. The polling of each sequence shall proceed independently of all others. The polling sequence shall be interrupted only when a terminal indicates readiness to transmit, when the concentrator has a message for a terminal in the sequence, or when additional input would cause an overload. The concentrator shall provide all interface features required by the terminals. The concentrator shall be capable of recognizing traffic activity and, during low traffic periods, increasing the time interval between polls by an adjustable factor. The concentrator shall return to the normal polling rate during periods of high traffic.

3.3.2.10.7 Concentrator to Message Switch. The concentrator shall accept information from terminals, break the information stream into frames in accordance with the NADIN procedures, and (except for locally switched traffic as discussed in Section 3.4.7.6.1) transmit the frames to the switch using NADIN link control procedures. The concentrator shall provide all necessary code conversion, format conversion, speed conversion, and buffering. The concentrator shall transfer the message to the switch in the code and format received, unless conversion to NADIN format and code is indicated. Conversion to NADIN format and code shall be determined by concentrator input circuit.

3.3.2.10.8 Network Control. The transfer of messages from the switch to the concentrator and from the concentrator to the switch shall be controlled as needed by network control and network status messages. As part of the CPFS (see Section 3.5.2.1.1), the contractor shall describe, with supporting analysis, the means to ensure coordinated message transfer between the switch and concentrator and terminals, the use of network status and network control messages in effecting the coordination, and how the contractor will meet these requirements based on the performance and capacity requirements stated in Appendix Z.

3.3.2.10.9 Training Concentrators

The system shall support the functional requirements of the test and training concentrators. These functional requirements are as follows:

a. Training concentrators shall not be permitted to send messages beyond the switch with which tests are being conducted.

b. Training concentrators shall be able to operate in the receive only mode i.e., no input shall be permitted from test terminal by supervisory command.

c. Training concentrator traffic shall be accountable or unaccountable based on circuit classmark.

d. The training concentrator at the FAA Technical Center shall have the capability to route messages from one station in its configuration to single or multiple stations within its configuration only.

e. The training concentrators at Oklahoma City shall have the capability to route messages through the switch to each other only.

f. For planning purposes the traffic loads on the test and training concentrators shall be capable of handling up to the normal concentrator traffic loads specified in Table Z-5, appropriately modified to reflect the particular port configuration. However, the total system throughput requirement shall remain as specified in Table Z7-A and Z7-B.

No special software shall be required to support the above functions. NADIN system capabilities such as implied routing, supervisor commands, address restrictions and associated procedures should be used to support the test and training concentrator requirements.

3.3.2.11 Concentrator Failures

Under normal operating conditions, failures may occur that will adversely affect concentrator operation. Subsequent paragraphs describe certain possible failures and the actions which shall be taken to correct them.

3.3.2.11.1 Node Failures. Node failures are defined as faults that occur within one of the two following areas:

a. The terminal associated with a concentrator.

b. The concentrator hardware or software.

3.3.2.11.1.1 Terminal Failure Detection. Terminal failure shall be determined in part by the type of terminal in question.

a. If a terminal with no response capability has not generated traffic during a given time interval (greater than the procedural interval for generating a circuit check message), the concentrator shall assume the terminal is in a failed status and shall send a status message to the switch. This function shall be optional by circuit.

(1) The time period before failure is assumed shall be an adjustable parameter within concentrator software, varying from 5 minutes to 25 minutes, in 5-minute or smaller increments.

(2) Independent timers shall be set for each terminal, via a table-build statement.

(3) Once the time limit is exceeded, the timer shall be reinitialized.

b. If a terminal with response capabilities does not answer consecutive polls, and the circuit facilities are determined to be in working order, the terminal is classified as being in a down status. The number of consecutive polls constituting a terminal failure shall be an adjustable parameter by circuit via table-build statement.

3.3.2.11.1.2 Remedial Action. Upon determination of a terminal failure or if a periodic channel check message is not received, the concentrator shall immediately notify the switch of the terminal or circuit status via a network control message. In the case of terminal failure the switch shall inhibit further message transfer to that terminal. In instances where a periodic channel message is not received, NADIN shall continue to transfer messages over those uncontrolled international circuits.

3.3.2.11.1.3 Failure During Message Transfer. A terminal may fail while transmitting a message to its concentrator, or it may fail while receiving a message.

a. If the message transmission is interrupted within the header (before STX or equivalent), the concentrator shall ignore the message. The terminal, not receiving an acknowledgement from the switch, must send the message again.

b. If the entire header (through STX or equivalent) was received, the concentrator shall follow the procedures of Section 3.3.2.2.7.3.

c. In the event that the terminal fails during receipt of a message, it is the responsibility of the terminal operator to examine the received portion of the message and determine whether a retransmission is necessary when the device is returned to normal operating condition.

3.3.2.11.1.4 Restoration of a Terminal. When a terminal indicates to the concentrator that its operational status is restored, either by answering polls or by generating traffic, the concentrator shall inform the switch of the restored status.

3.3.2.11.2 Concentrator Failure Detection. Determination of a concentrator node failure shall be made by the switch (see Section 3.4.7.8).

3.3.2.11.3 Restoring a Concentrator to Operational Status. The concentrator shall be capable of reinitializing its operating system and of accepting down line load from the switch. If an automatic command from the switch for reinitializing the concentrator fails, it will be necessary for a switch operator to call on the ARTCC to request

manual reinitialization of the concentrator. For this purpose, each concentrator shall be equipped with a control panel indicating status, alarms, and control switches for reinitialization.

3.3.3 Interfaces, Circuits, and Terminals

NADIN requires a wide range of capabilities to perform the data services required. The operation of the NADIN interfaces with other systems and networks, NADIN circuits and terminal equipment provide the complete message transfer capability. These interfaces may be either asynchronous or synchronous, and may be either character oriented or bit oriented.

3.3.3.1 Interfaces

Required interfaces for NADIN operations are listed in Appendix Z and described in the appropriate Appendices.

3.3.3.1.1 Error Detection and Recovery. All NADIN interfaces described in Section 3.3.3.1, except for the low speed interfaces (50 and 75 b/s), provide error detection and recovery procedures at the link level. Minimum error detection shall be provided by use of the Block Check Character (BCC) and parity on X3.28 character oriented links and Cyclic Redundancy Check (CRC) on bit oriented links. Parity error checking is provided on NADIN-NAS 9020 links.

3.3.3.2 Terminal Failure

A terminal will not generally be provided with automatic back-up provisions in case of failure (see Sections 3.4.9.1 and 3.4.9.2). However, selected users will be provided dial back-up. These include:

a. FDIO,
b. Canada.

3.3.3.3 Terminals

Terminals connected to NADIN may be Government or non-Government operated, owned or leased, and communicate in 5-level ITA-2, 7-level IA-5 code, ASCII, or ICAO-7 code (see Section 3.4.9 and Appendix S, NADIN/Data Terminal Equipment).

3.3.3.4 Circuits

The contractor shall provide the capability for each concentrator and switching center to establish circuits to terminal devices, other network nodes, or interfaces as required by this specification. Link control procedures shall be selected to provide the most efficient and effective method of communication where not otherwise specifically defined.

3.3.3.4.1 Circuit Failures. Occasionally a dedicated communication circuit may fail.

a. Upon determination of a circuit malfunction, the appropriate remedial action shall be taken:

1. Implement dial back-up to replace the failed circuit if available.

2. Hold traffic to a terminal at the switch if a dial back-up is not provided.

3. Generate a message to an operator at the switch to initiate repairs.

b. Messages interrupted by a circuit malfunction are handled as follows:

1. Where frame control is provided, lost frames are retransmitted.

2. When the message is partially received at the concentrator, it shall be forwarded to the switch (see Section 3.3.2.11.1.3).

3. Messages partially received by a terminal shall be recovered, where necessary, by an operator request for retransmission from the switch.

c. Once a malfunction has been corrected, the system shall resume normal operation:

1. The controlling node shall drop the dial back-up and resume normal operation.

2. The concentrator shall inform the switch of the restored status of a terminal thereby releasing all traffic being held for that terminal.

3.3.4 Communication Formats

3.3.4.1 Message Formats

The NADIN concentrator shall provide conversion from the originator's message format to a format for internal NADIN processing and from the internal NADIN format to a format applicable to the destination. These conversions shall include:

1. Addition and deletion of upshift and downshift characters as required for effective code conversion.

2. Addition and deletion of control characters or sequences as specified in the applicable appendices.

3. Rearrangement and/or revision of header information to be consistent with the applicable appendices.

4. Any other conversions necessary to assure effective, meaningful intercommunication between the originating and destination systems.

In general, only one communications message format will appear on a user circuit. However, circuits may be designated as capable of handling bit stream. The switch-switch and concentrator-switch circuits (trunks), however, shall accommodate multiple communications message formats and shall be capable of handling textual data in any code or bit-stream configuration. Messages shall be handled one at a time between terminals and concentrators. Maximum message size (SOM to EOM) shall be 3700 characters, except for messages to or from AFTN circuits, in which case the maximum message size shall be 1400 characters or to the NAS 9020 computer, in which case the maximum message text size shall be 800 characters and is measured from STX to ETX. New Ending Procedures (ICAO Manual Annex 10, Volume II) shall be employed on any excess length message (except those to or from the NAS 9020 which are discussed below) and a service message shall be automatically generated and sent to the originator (excessive length message will only be determined on input).

All message formats using 7-level code (IA-5 or ICAO-7) shall be consistent with the provisions of FIPS Publication 1.

The message size on delivery (except to the NAS 9020 computer) may exceed the maximum in cases where NADIN generated data causes the received message to expand beyond maximum message size (generally less than 50 characters). All messages addressed to the NAS 9020 computer in excess of 800 characters shall

be routed to the NAS 9020 DTE position. However, a maximum of 3700 characters shall be routed to the DTE position. When the message exceeds 3700 characters, then NADIN truncates the message at 3700 characters and follows the procedures defined in Section 3.3.4.1, Message Formats, except that the message shall be routed to the destination NAS 9020 DTE. On output from the NAS 9020 computer, there is a 3700 character message length restriction. The NAS 9020 computer is the only interface which permits different maximum message length on input versus output. All other NADIN interfaces have message lengths which are identical on input and output. Over long messages received by NADIN from the NAS 9020 computer should be handled as follows: send STX followed by SVC followed by the remainder of the service header line followed by the first 100 characters of the over long message received from the NAS 9020 computer, back to the originator NAS 9020 computer.

3.3.4.1.1 Service B. The Service B format shall be used at FAA terminal locations presently served by Area B circuits (See Appendix D).

3.3.4.1.1.1 NADIN Response. When the switch has accepted a message, it shall return a response to the terminal indicating acceptance of responsibility for the message . The required fields of the response message, in order, are Date Time Group (DTG), Originator address, Supervisory Information, Message Separator, and End of Message (EOM), as follows:

(a) DTG consisting of six numerics indicating day, hour, and minute the message was received at the switching center.

(b) Originator address of six or eight characaters identifying the ICAO address of the terminal entering the message.

(c) Supervisory information indicating the link identification, message number by 24 hour clock (sequential) and other contractor recommended data. This information shall not exceed the remainder of the origin line, and shall end with CR LF.

(d) Message Separator consisting of four to 10 line feeds, setable by terminal address, via table-build statements.

(e) EOM consisting of NNNN.

3.3.4.1.2 AFTN. The AFTN message format is defined in ICAO Annex 10, Volume II for ITA-2 and IA-5 (ICAO-7) coded messages. The specific format to be employed for each AFTN interface are specified in the corresponding appendices to this specification. For messages transiting international circuits of the AFTN (as opposed to national circuits controlled solely by the U.S.A.), the contractor shall provide a capability to insert and delete the second carriage return in the alignment function. The NADIN shall have the capability to employ the use of multiple lines of addresses, but shall process them into multiple messages before passing them to the high level network or to circuits identified as AFTN (ITA-2 and IA-5) to ensure that no more than one line of addresses remains in the message after address stripping has been applied.

3.3.4.1.3 NADIN Information Message. The NADIN Information Message format is the basic message format for the system and shall be employed for specified IA-5 (ICAO-7) messages to and from unintelligent and intelligent terminals, and computer interfaces. Appendix Z defines those circuits for which NADIN format is to be used. However the particular elements of the NADIN format to be used for a particular interface shall be in accordance with the appropriate Interface Control Document. The input format from unintelligent terminals is modified by not requiring the supervisory information, date-time group, and origin indicator. The required fields for the message, in order, consist of Start of Heading (SOH), Supervisory Information, Priority, Addresses, Date-Time Group (DTG), Origin, Start of Text, Text, End of Text (ETX). The message elements are as follows:

a. SOH consisting of the IA-5 character 0/1.

b. The IA-5 Group Separator (GS) character 1/13, optional by circuit basis.

c. Supervisory information consisting of the Transmission Identification (per ICAO Annex 10, Volume II), plus any other information pertinent to the link recommended by the contractor for data integrity not to exceed the remainder of the line. The line shall end with CR LF. Supervisory information is not mandatory from IA-5 terminals having automatic recovery capability.

d. Priority indicator consisting of the appropriate two alphabetic characters.

e. Delimiter consisting of space character 2/0.

f. Addresses consisting of a space and three, four, six, or eight characters to identify each destination for the message. The end of each line of addresses shall be completed with CR LF. The last address shall be followed by CR LF, file separator.

g. Date-time group consisting of six numerics indicating day, hour, and minute the message was prepared. This is not required from circuits so classmarked.

h. Delimiter consisting of space character 2/0

i. Message originator consisting of six or eight characters identifying the ICAO address of the terminal location entering the message. This is not required from circuits so classmarked.

j. Additional data field. See paragraph 3.3.4.1.6.

k. Delimiter - end of line sequence consisting of CR LF.

l. Text shall be constructed as follows. The first character in text shall be the start of text character 0/2 and shall always be present. Text shall consist of alphanumeric (stream of IA5 characters) or graphic (stream of 8 bit octets) text. The total message size shall not exceed 3700 characters or multiples of 8-bit octets which shall be counted from start of message (SOM) to end of message (EOM). Each line of text shall end with carriage return, line feed except that the last line shall end with CR LF VT. NAS 9020 message traffic shall be processed as specified in Appendix F.

m. ETX consisting of the IA-5 character 0/3.

3.3.4.1.3.1 NADIN Response Message. The NADIN switching center shall respond indicating acceptance of the message only for those terminals class-identified as unintelligent. This response shall indicate acceptance by the switching center. Intelligent terminals will transmit all required fields of the message with message accountability and accuracy automatically provided through use of the link control procedure when required. The required fields of the response message to unintelligent terminals, in order, are STX, Date Time Group (DTG), Originator Address, Supervisory Information, Message Separator, and End of Text.

(a) STX consisting of the IA-5 character 0/2.

(b) DTG consisting of the six numerics indicating day,hour, and minute the message was received at the switching center.

(c) Originator address of six or eight characters identifying the ICAO address of the terminal entering the message.

(d) Supervisory information shall consist of the IA-5 character GS, followed by the Transmission Identification (per Annex 10, Vol. I), plus any other information recommended by the contractor for data integrity and disposition of the message by the switching center. This information shall not exceed the remainder of the line and shall end with CR LF VT.

(e) ETX consisting of the IA-5 character 0/3.

3.3.4.1.4 NADIN Network Management. NADIN network control messages are used to manage the network resources and may consist of any bit combination in the link data field subject to the following restrictions:

a. A maximum of 2000 bits.

b. Bits are used in increments of eight-bit bytes, called octets.

c. The Communication Control Field (CCF) is annotated, by setting the MT bit, to indicate a network control message format.

3.3.4.1.5 Message Types. Deleted.

3.3.4.1.6 Additional Data Field (ADF). This section is no longer valid because the Additional Data Field is not being used within NADIN. The Additional Data Field may be used between networks other than NADIN. NADIN shall not process any data, located in the ADF, to support its system functions. If the Additional Data Field is used, the format shall be in accordance with ICAO Annex 10, Volume II, Paragraph 4.4.18.1.3. If the Additional Data Field is being used, a space (character 2/0) after the origin shall be indicated. The Additional Data Field shall be terminated with either an end of line function or a STX. If an Additional Data Field is present it shall begin with a space character and shall have a maximum length of 52 characters. Transmission control characters shall not be permitted.

NADIN shall be transparent to the content of the additional data field and tolerant of its optional occurrence after the originator address. If an ADF is used a space character shall follow the originator address. The ADF shall not exceed the remainder of the origin line. It shall end with whatever character or sequence would ordinarily terminate the originator address were the ADF not present.

If an origin line is required on output NADIN shall repeat the input ADF, if any. If the output message is SS priority and no input ADF was supplied NADIN shall supply the priority alarm sequence following the originator address. NADIN shall not supply the priority alarm sequence if an ADF was present on input or if no originator line is called for (by circuit format) on output.

3.3.4.1.7 NADIN Response Messages. The contractor shall provide a capability at each switching center to generate responses to each terminal on classmarked circuits and interfacing system to ensure message accountability and responsibility, node and terminal connectivity, line status, and network status, as required.

3.3.4.1.7.1 NADIN Teletypewriter Terminals. All terminals on classmarked circuits shall receive a positive response to each input message to indicate to the operator status of messages. The response indicated in Sections 3.3.4.1.1.1 and 3.3.4.1.3.1 shall indicate normal system acceptance of a message.

3.3.4.1.7.2 All NADIN Terminals. For all terminal input, both accountable and unaccountable, input responses other than normal shall include an indication to the terminal operator of the status of the input message, terminal, or network as required. The indicator repertoire shall include as a minimum the following:

a. Message Edit Failure. Response shall indicate the parameter or field of the input message that failed to pass edit. When an input terminal or circuit has been selected to refer edit failures to the edit service position, the service message to the originator shall be omitted except for service messages responding to overlong messages as specified in section 3.3.4.1.

b. Routing Failure. Response shall indicate messages that cannot be delivered (each must be indicated) and the reason, such as terminal address undefined, illegal destination for input source, etc.

c. Circuit Continuity. On uncontrolled international circuits the NADIN switching centers shall, in the absence of any other data to transmit to the terminal, periodically generate a message to each terminal on such circuits. The timing shall be selectable, by circuit, for 5-, 10-, 15- or 20-minute intervals and shall include, as a minimum, the current DTG, last message number sent and last message number received.

d. System/Network Status. Each switching center shall have the capability to transmit appropriate status messages to terminals and interfaces concerning abnormal NADIN conditions that could have caused a loss of service and messages. These messages shall be sent to locations as specified in a failure notice group address table. This table shall be constructed by table-build statements.

3.3.4.1.8 Communication Data Field (CDF) Format. The Communication Data Fields consists of a control block followed by the message text. In addition a control block extension of variable length may be appended after the text portion of the CDF. The text portion of the CDF shall not exceed 2000 bits. The control block characters which precede and in some cases also follow the text shall not add more than an additional 448 bits. The network entry processor (either switch or concentrator) will structure the control block containing encoded information to accompany data being passed between various NADIN processing modules. The contractor shall implement the control block in a format consistent with his network design and this specification. The message text shall be in accordance with Section 3.3.4 or the governing Interface Control Document.

3.3.4.2 Communications Control Field (CCF) Format

This format is required when an information or network management message transits NADIN circuits between switching centers (high level network) and between switching centers and concentrators. The CCF comprises information required to exercise communication control, i.e., the control functions required for correct message handling after the message or message part has "cleared" the DLCF function. The CCF and the CDF together form the Link Data Field. The CCF shall be in the format described below and further illustrated in Figure 3.3-3.

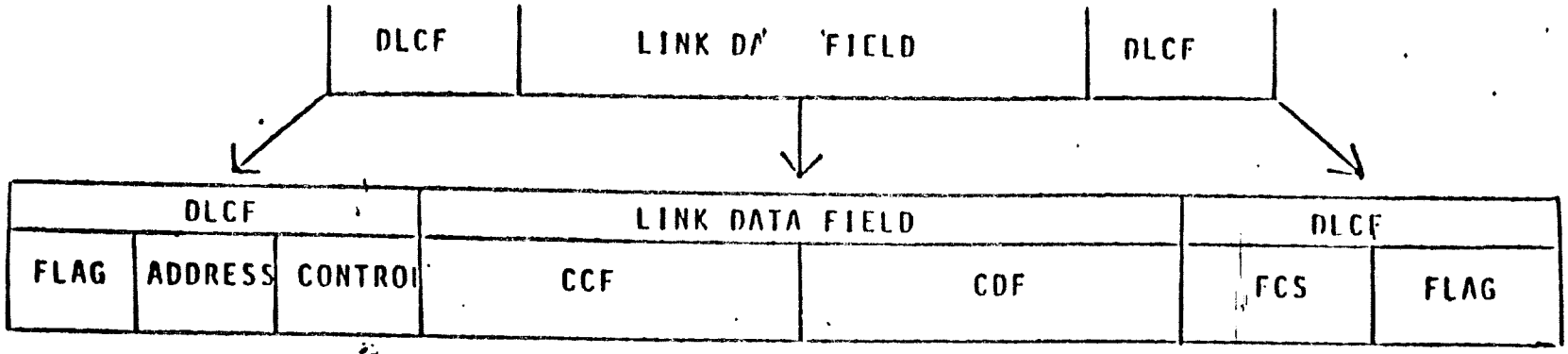
a. Field 1: Bits 2 and 1 identify the message priority which shall be interpreted as follows:

- o 00 low priority,
- o 01 medium priority,
- o 10 high priority,
- o 11 highest priority.

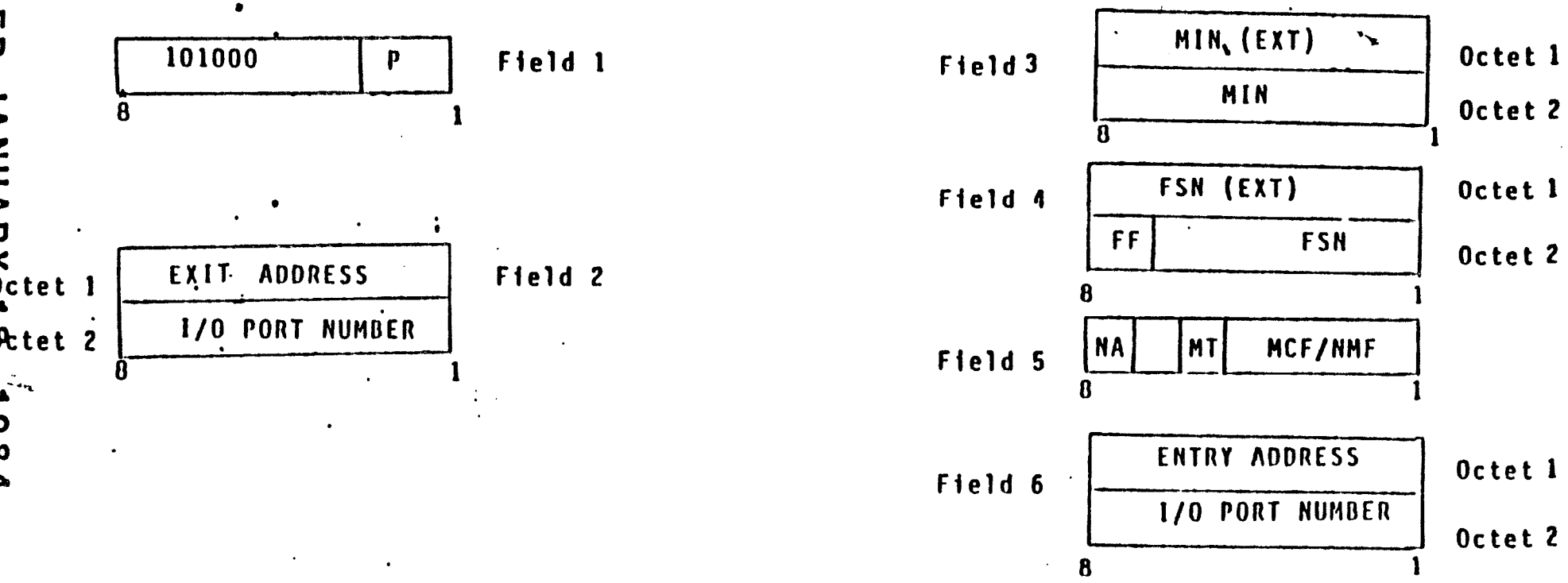
Bits 8 through 3 shall be 101000 respectively.

b. Field 2: Field 2 consists of two octets to completely specify the network exit address. The first octet is the exit address which identifies the NADIN exit node (concentrator or switch) to which the frame is to be transmitted. The exit address values of all binary ones and all binary zeros shall be reserved. In the second octet bits 1 to 8 identify the appropriate I/O port number at the NADIN exit node. (Not used on switch to switch link).

c. Field 3: Field 3 consists of two octets which together denote Message Identification Number (MIN), providing a range of 65,536 numbers. MIN values are assigned sequentially by network entry node and exit and shall be consistent with other NADIN MIN assignments contained in this specification. Octet 2 is used for MIN's of less than or equal to 256 with Octet 1 reserved for use when MIN numbers exceeding 256 are needed.



A. BASIC FRAME CONSTRUCTION



B. CCF CONSTRUCTION

COMMUNICATION CONTROL FIELD

d. Field 4: This field consists of two octets. Octet 1 is used to provide a future capability for extended numbering for Frame Sequence Numbers (FSN). In Octet 2 Bits 1 to 7 are the first seven binary digits of Frame Sequence Number. The FSN indicator identifies the sequence number of each frame of a multiframe message. The FSN shall be assigned in sequence beginning with all zeros. Bit 8 in Octet 2 is the final frame indicator being one for the last frame of a multiframe message, or the only frame of a single frame message, and being zero for all other frames.

e. Field 5: This field consists of a single octet. Bits 1 to 5 comprise the MCF/NMF, interpreted according to the setting of bit 6 as either a message code and format component, designating the code and format type or a network management function component, designating one of 32 possible network management message types. Bit 6 indicates message type and determines the order of transmission as follows: MT = 1 network management message and MT = 0 information message. Bit 8 is the network acknowledgement indicator and set to 0 to indicate acknowledgement not required, and 1 to indicate acknowledgement required. In this application bit 7 is not used and is always set to zero.

f. Field 6: This field consists of 2 octets. Octet 1 is the entry address which identifies the NADIN entry node that accepts the message on input to the network. The entry address values of all binary ones and all binary zeros shall be reserved. In Octet 2 of field 6 Bits 1 to 8 identify the appropriate NADIN entry node's I/O port number for the originating circuit which input the message to the NADIN entry node.

3.3.4.2.1 Switching Center to Switching Center. This section has been deleted and the technical content incorporated into Section 3.3.4.2.

3.3.4.2.2 Switching Center to Concentrator. This section has been deleted and the technical content incorporated into Section 3.3.4.2.

3.3.4.2.3 Concentrator to Switching Center. This section has been deleted and the technical content incorporated into Section 3.3.4.2.

3.3.4.2.4 NADIN to Other Networks and Systems. When the NADIN interconnects over circuits or channels using bit-oriented procedures, a CCF and CDF are optional. However if used the CCF shall follow Section 3.3.4.2 of this specification.

3.3.4.2.4.1 Message Sequence Numbering. For those links to other networks in which message accountability is maintained by message sequence numbering, the NADIN shall verify the continuity of input message sequence numbers. The contractor shall

provide logic that maintains circuit operation when user supplied input message sequence numbers are out of order, garbled or missing, and automatically notifies the transmitting station. Upon detection of a sequence error, missing, or otherwise unidentifiable sequence number from a station, NADIN will increment by one the previously received sequence number, sending a service message designating the incremented sequence number to the originator of the last message sequence number. If the sequence number detected is larger than expected, NADIN will use this new number incremented by one as the next expected sequence number sending a service message designating the missing sequence numbers to the originator of the last message sequence number. In every case of sequence numbering errors, transmission of the messages should continue and the switching center operator shall be notified. Sequence numbering within NADIN shall be as follows:

1. The range of sequence numbers should be from 0000 to 9999 or from 000 to 999 depending on circuit's classmark.

2. Sequence number 0000 (or 000 for classmarked circuits) shall never be used.

3. All input/output sequence numbers will reset to 0001 (or 001 for classmarked circuits) at the end of the radio day or following switching center failure if necessary.

3.3.4.2.5 NADIN Network Control Messages. The contractor shall provide a method of generating, detecting, and exchanging network control messages for determining status of network nodes, interfaces, and circuits, and controlling and monitoring the flow of data between switching centers, and switching centers and concentrators.

3.3.4.3 Data Link Control Procedures

The high-level link procedures as defined by Appendix A, shall be the data link control procedure used over the switch-to-switch and switch-to-concentrator communication links.

3.3.4.3.1 Link Address. The addressing octet of the data link control field (DLCF) shall be used without extension. Octets containing all ones (11111111) and all zeros (00000000) shall not be used for normal address assignments.

3.3.4.3.2 Link Control. Options provided by the control octet of the DLCF shall be chosen on the basis of network configuration.

3.3.4.3.2.1 Control Field Extension. All NADIN backbone (switch-switch and switch-concentrator) links shall operate in the basic control format. This format allows the primary or secondary of the link to have a maximum of seven frames outstanding. If long delays occur that are due to a primary or secondary waiting for acknowledgement of outstanding frames, the link shall use the extended control format. The extended format allows for a maximum of 127 outstanding frames. The link, however, shall be configured to allow a maximum of only 15 outstanding frames before generating the appropriate alarms.

3.3.4.3.2.2 Operational Mode. The switch-to-switch link and switch-concentrator links shall operate in the asynchronous balanced mode (ABM) for both primary and back-up configuration.

3.3.4.3.2.3 Disconnect Mode. A combined station in the asynchronous balanced mode responds to a disconnect command by entering the asynchronous disconnect mode.

3.3.5 (EX) Operational Instructions. Deleted.

3.3.6 Secondary Storage Labels

All removable secondary storage media used by the NADIN operational program component shall have automatically generated opening and closing labels in accordance with ANSI X3.27 that identify the data contained therein, opening and closing times, retention or purge time of data, and other information needed to meet the requirements of this specification. All removable secondary storage media shall have opening labels checked by the software and the media shall not be accepted by the NADIN system for any function that could result in an overwrite of its contents unless the retention time has expired. The contractor shall generate and print external labels based on information extracted from the opening and closing labels.

3.4 NADIN System Hardware

3.4.1 NADIN Switching Center

The NADIN switch shall be a high speed, general purpose, digital, solid state, stored program, data switching system. The NADIN switch shall be modularly expandable.

3.4.1.1 Switching Center Expansion

The NADIN switch shall be capable of expanding independently in throughput transfer capability, active memory capacity, the number of circuit terminations, and mass storage devices used to support the functional requirements set forth in this specification. As general guidance, the switch shall be modularly expandable to permit the "online" processing elements to grow. The contractor shall explicitly state the modular increments of the following contractor provided items:

a. Executable memory capacity,
b. Secondary storage capacity,
c. Tape transports,

d. Disk drives,
e. Input/output channels or equivalent,
f. Low speed line increments,
g. Medium speed line increments.

For each of the above elements, the contractor shall explicitly state the configuration limits at which additional controllers, multiplexers, cabinets, power supplies, etc., must be added.

3.4.1.1.1 Switching Center Growth Plan. The contractor shall submit as part of the design data a configuration growth plan showing how the system expansion requirements will be met (see Section 3.8.4). The contractor shall submit a plan detailing how the system can be modified according to the following constraints:

a. A message switching node shall not be totally disconnected from the network for more than six hours.

b. A message switching node availability in any interim configuration shall not degrade below 99.5 percent.

c. The current operating software system must operate on any interim hardware configuration.

3.4.2 Message Switch and Switching Center Failure

The message switch is the most critical element within NADIN and must have the highest degree of reliability. This section describes message switch and switching center failure conditions and the associated alternate message switching capabilities required within the NADIN. For purposes of this section, message switch failure refers to a condition in which an element fails but where sufficient alternate or redundant capability is available to maintain an operational status; a switching center failure is defined as a failure involving so many elements that an operational capability cannot be maintained at the center, and the remaining switching center must serve the entire network.

3.4.2.1 Message Switch Failure

Upon failure of an online switch element, the functions of the failed element shall be absorbed by a redundant element. The message switch shall accommodate changeover to redundant elements minimizing service interruption and providing complete traffic protection. The switch, operating with online redundant elements shall have the capability to reconfigure and resume operation automatically within thirty seconds and shall notify operating personnel of the new configuration. If automatic reconfiguration does not occur, the operator shall have the capability to initiate repeated recovery attempts. If the message switch failure is such that an Initial Program Load (IPL) is required, the NADIN shall have the capability to protect any traffic that may be trapped by the failed switch element. This protection refers to messages queued within the switch

at the time an IPL is required. The contractor shall provide the following traffic protection capabilities:

a. A method of storing all system data necessary to perform processing of traffic trapped within the failed element at a later time.

b. Software to process such data and recover as many trapped messages as possible.

c. A method for storing recovered messages in a format compatible for reinput into the online system.

The processing method for traffic trapped within the failed element shall minimize operating personnel intervention.

3.4.2.2 Switching Center Failure

Each switching center shall be provided with the capability to assume the functions of the other switching center, e.g., Eastern switch to assume all functions of both message switching centers. The switching center assuming such functions shall be provided with concentrator to switch direct dial access as specified in Appendix P to accommodate all concentrators associated with the failed switch. Once a concentrator has been connected to the surviving switching center, that concentrator shall be capable of performing all normal operations including local switching. Additionally, where appropriate, alternate data paths shall be provided for those users served directly from the failed switching center (not via concentrator interface) which do not maintain dual switching center access. Users for which alternate data paths shall be provided are identified in Appendix Z.

The contractor shall provide the capability to perform the following functions associated with a switching center to switching center back-up:

a. Steps required of the receiving switch to accommodate back-up, i.e., activation of line scan for failed switching center circuits, activation of appropriate tables, offline retrieval, and journalling requirements.

b. Supervisory console operator capability to activate and deactivate the concentrators of a failed switch individually, by group, or all at one time to include routing considerations as each concentrator is activated and deactivated.

c. Handling of queued switching center to switching center traffic as concentrators are activated.

d. Command and report requirements during switching center to switching center back-up operation.

e. Handling of queued switching center to switching center traffic as concentrators are returned to control of primary switching center.

f. Offline table-build requirements for the association of a particular line as a primary or back-up group, routing definitions via table-build to distinguish switching center to switching center trunk versus discrete back-up concentrator routing (see Section 3.5.4.1.8 covering table-build).

g. System software to accommodate down-line loading of a failed concentrator which is not a member of the switch's primary concentrator group.

The contractor shall provide system parameters to accommodate items (a) through (g) and additional points as required to implement switching center to switching center back-up operation.

3.4.3 Message Switch Trunking

3.4.3.1 NADIN Message Switch to NADIN Message Switch

Communications between the two NADIN message switches shall conform to the high level link procedures as defined by Appendix A. The CCF shall conform to Section 3.3.4.2.

3.4.3.2 Switch-to-Concentrator Communications

The message switches shall communicate with the NADIN concentrators over leased voice grade communication lines at 9600 b/s and over 4800 b/s dial backup circuits. Concentrators shall be placed on communication circuits in a point-to-point configuration.

3.4.3.3 NADIN to Other Networks

The NADIN message switch shall be capable of interfacing to other networks. This capability must be modular. The interfaces to other networks (as defined in Section 3.3.3.1, Interfaces) shall conform to the applicable Interface Control Documents. These interfaces may be either asynchronous or synchronous, and may be either character oriented or bit oriented.

3.4.3.3.1 to 3.4.3.3.3 Sections deleted.

3.4.4 Circuit Requirements

3.4.4.1 Circuit

The NADIN switch shall be capable of interfacing to the following types of communication circuits.

3.4.4.2 Low-Speed Data Grade Circuits

The switch shall be capable of interfacing directly to point-to-point and multipoint circuits operating in an asynchronous mode and at speeds ranging from 50 to 300 b/s.

3.4.4.3 Medium-Speed Circuits

The NADIN switch shall be capable of directly interfacing to medium-speed circuits operating synchronously or asynchronously at speeds ranging from 300 b/s to 9600 b/s.

3.4.4.4 Switch Port Requirements

The NADIN switch shall be capable of initially serving quantities of circuits indicated in Appendix Z.

3.4.5 Message Switching Center Ancillary Equipment

The NADIN switch configuration shall be capable of interfacing to local peripheral units. These peripheral units may be of different types and capabilities necessary to meet the stated functional requirements. They may include but are not limited to the following:

a. Supervisory consoles for offline and online system control;

b. Secondary storage devices (such as disc, drum, magnetic tape transport, floppy disc, etc.);

c. Card reader and card punch for offline support;

d. Line printer for core dumps, statistical analysis, diagnostics, and other offline applications;

e. Service operator position;

f. Program data entry device.

3.4.5.1 (EX) Operator Functions. Deleted.

3.4.5.2 Supervisory Console

Refer to Appendix SS as the governing document for console functions, positions, designs, and locations. The supervisory console of each switching center shall have the capability to monitor and control all circuits, concentrators, and ancillary equipment directly connected to or part of its switching center. This capability includes configuration control of concentrator and switching center elements. If one of the switches is inoperable, the surviving switch shall control all circuits according to Section 3.3.2.9.5 and 3.4.2.2.

3.4.5.2.1 Console Functions. The contractor shall design and provide suitable commands and response messages, access restrictions amendment, and display formats for the console operators use. Data access control and display capability shall include, but not be limited to, the following types of functions:

a. Assignment of functions and control of access for the service positions and maintenance console.

b. Display of all I/O circuit parameters.

c. Listings of all systems subscribers, by circuit and address, including CDC and TSC's.

d. All system routing tables, prime and alternate, including dial access, and routing parameters.

e. Instructions and commands for opening and closing circuits, programmed test messages, and circuit error reporting.

f. Control of offline and online elements necessary for testing of software changes and running the non-operational programs.

g. Entry of program changes and updates into offline and online elements.

h. The circuit status and visual alarms specified in Section 3.6.3.2.3.

3.4.5.2.2 Console Design. The contractor shall provide a suitable console equipped with display, monitoring, entry devices, output devices, and control panels including a KVDU terminal in accordance with Section 3.3.2.2.3.5.1 for performing this function. Printing devices shall be capable of printing at a minimum of 30 CPS (characters per second), with 80-character horizontal lines using sprocket-feed, 3-ply, fan-fold paper. Data displayed on the visual display shall be capable of being selected for printing by the console operator. Messages to the visual display device shall have a two-priority queue with a capability for indicating status of each.

3.4.5.3 Card Reader and Keypunch

The card reader shall be capable of reading, as a minimum, 200 c/m (cards per minute) that conform to FIPS PUB 13 and 14. The keypunch shall be keyboard operated (equivalent to IBM Model 029) and conform to FIPS PUB 13 and 14.

3.4.5.4 Line Printer

The line printer shall, as a minimum, print at 1200 l/m (lines per minute), 95 character ASCII code, 120 characters per line, 10 characters per inch horizontal spacing and 6 lines per inch vertical spacing. The printer shall produce 6 readable copies using 6-ply, sprocket-feed, fan-fold paper that conforms with MIL-P-40023.

3.4.5.5 Magnetic Tape Transport

Unless otherwise stated, all magnetic tape transports shall be 9-track, 1600 CPI, P.E. and conform with FIPS PUB 25 and ANSI X3.40.

3.4.5.6 Magnetic Tape Cassette

If any magnetic tape cassettes are supplied with the system, they shall be fully compatible and interchangeable with each other.

3.4.5.7 Service Operator Console

Refer to Appendix SS as the governing document for console functions, positions, designs, and locations. The service operator's console shall be a KVDU or equivalent type device providing for display of mesages, keyboard entry for correction and message preparation, reentry of displayed messages, and optional printing on a local printer. Data transfer rate between the switch and console must be a minimum of 1200 b/s, employ ASCII, and use a printer capable of at least 30 c/s. The KVDU shall have characteristics as described in Section 3.3.2.2.3.5.1, System Intercept Position Configuration.

3.4.5.8 Data Structure and Signalling

The structure of data bits, order of transfer, parity sense, and signalling requirements, when using 7-level code shall be consistent with the provisions of FIPS PUB 16, 17, 18, 22, EIA-STD-RS-232, 404, 269 and ANSI X3.24.

3.4.5.8.1 Real Time Clock. The contractor shall provide a real time clock for the switching centers. The clocks may be internal (a part of the computing elements) or external with time available to the switching centers through local input/output channels. The switches shall provide real time clock information to their associated concentrators. Clock output shall provide digital time information in hours and minutes on a twenty-four hour basis. Console displays shall be in hours and minutes. Clock accuracy shall be maintained by a Government-furnished Coded Time Source (CTS) System located in each ARTCC. Details on the Government-furnished CTS interface requirement will be provided to the contractor.

3.4.6 Primary Power Failure

The message switch shall be guarded against primary power failure by the following means:

a. The message switch shall be fully compatible with Government-furnished Uninterruptible Power Supply Modules as specified by FAA-E-2473. When the switch is powered by the above supply, it shall be capable of continuous, uninterrupted, nondegraded operation (see Section 3.14.2).

b. A power-fail, auto restart feature shall be provided within the message switch if a power failure does occur. The power-fail feature shall provide for an orderly shutdown of the switch node, such that when power is restored, the auto restart will return the switch to an operational status without the need for manual intervention.

3.4.7 NADIN Concentrator Requirements

Function requirements as specified herein shall apply to all concentrators within NADIN.

3.4.7.1 Concentrator Characteristics

The concentrator shall be comprised of a stored program digital computer and related communication peripheral devices, allowing it to transfer messages between the NADIN message switching center and all terminals, and local switching between the NAS 9020 computer and FDIO terminal (i.e., without switching center involvement). NADIN concentrators will provide 24-hour service and will be capable of expansion to meet projected needs. The NADIN concentrators shall have the following characteristics, as a minimum:

a. Basically an off-the-shelf system with modifications or custom features necessary to perform the functions detailed in this specification.

b. Capable of easy expansion to meet changing needs with a minimum of reprogramming and no overall concentrator down time.

c. Highly reliable and easily maintained, monitoring its elements and detecting its failures.

d. Provided with sufficient memory, arithmetic and control, and input/output elements in an online status so that element failures will not result in node failures.

e. In conformance with certain minimum hardware functions that are separately stated in this specification.

f. The NADIN concentrators shall be general purpose, high-speed, solid state, digital, stored program computers.

g. Failures shall be defined on a modular unit with respect to that unit's effect on over-all concentrator performance.

h. The number of elements required within a concentrator shall be determined by the capability of a particular element to meet peak traffic demand. Further, there shall be sufficient back-up elements to meet the reliability standards outlined in this specification.

i. The NADIN concentrator shall be provided with a magnetic storage device. This device will be used to hold concentrator maintenance programs. This device shall be in accordance with the applicable Federal or ANSI standards.

3.4.7.2 Concentrator Functions and Responsibility

The concentrators within NADIN shall be capable of performing the following functions, as a minimum:

a. Provide an interface between various types of terminals and the NADIN message switching center.

b. Provide an interface between NADIN and the NAS 9020 computers located at each ARTCC. (See IBM Document IBM-7289-2 IBM Peripheral Adapter Module Field Engineering, Maintenance Manual, 9020 Systems).

c. Provide device control, code conversion, speed conversion, and format conversion (reference Section 3.3.2.2.3.3) as required between the message switch and the various terminals, including the NAS 9020, and as required for local switching between FDIO terminals and the NAS 9020 computer.

d. Continuously monitor terminals, on a polled basis (for polled terminals), for any message activity.

e. Accept messages from the terminals and if not eligible for local switching (see Section 3.4.7.6.1), transfer them to the message switch, and accept messages from the message switch and transfer them to the respective terminals.

f. Monitor communication circuits and terminals for possible failures.

g. Take appropriate remedial action where a failure is detected.

h. Interact with the message switching center to provide the specified network control.

i. Assist the terminal operator in generating communications elements of the message format.

j. Provide local switching of messages from FDIO terminals to FDIO terminals, FDIO terminal to NAS 9020 computer and NAS 9020 computer to FDIO terminal (as specified in Section 3.4.7.6.1).

3.4.7.3 Concentrator and Switch Connection

The message switches shall communicate with a minimum of 23 NADIN concentrators over leased voice grade communication circuits at 9600 b/s and over 4800 b/s dial back up circuits.

a. Concentrators shall be placed on communication circuits in a point-to-point configuration.

b. In case of primary leased-circuit failure, the message switch shall be capable of communicating with its associated concentrators on a point-to-point basis, exclusively, over a dial-up switched network. Primary circuits shall be capable of being served by both digital and analog service.

3.4.7.4 Message Collection

Messages are collected by the concentrators from multipoint terminal circuits on a polled basis, according to a polling list, with the concentrator simultaneously accessing all

circuits. The concentrator accepts messages in the format, speed, code, and protocol of the origination terminal. The concentrator is responsible for dividing messages into standard frames or blocks of messages and transferring them to the message switch as specified herein, or where applicable providing direct local switching for FDIO and NAS 9020 computer messages.

3.4.7.5 Concentrator-Terminal Protocol

The concentrator shall communicate with its respective terminals in the format, code and speed of the terminal. Terminals shall be grouped upon a single communication circuit according to the speed, code, and format required.

3.4.7.6 Concentrator Message Handling

The concentrator shall be responsible for dividing incoming messages into standard frames or blocks and forwarding the message to the message switching center on a frame-by-frame basis except for local switching of messages between FDIO terminals and NAS 9020 computers as discussed in Section 3.4.7.6.1. The concentrator shall have no online secondary storage associated with normal operation and shall not be responsible for message accountability to the message originator. The NADIN concentrators shall be normally operated in an unattended mode. Operator intervention shall be required only during adverse conditions identified in Section 3.4.7.8 of this specification.

3.4.7.6.1 Local Switching at the Concentrator. NADIN concentrators shall perform local switching of messages between FDIO terminals and NAS 9020 computers at the concentrator, i.e., concentrator port to concentrator port exclusive of the switch as defined below in Section 3.4.7.6.1.1. In addition, hardware and software configuration shall be designed in such a manner as to simplify implementation of any future modification or modification to provide full local routing capability for any concentrator port as defined in Section 3.4.7.6.1.2.

3.4.7.6.1.1 Local Switching Implementation for FDIO and NAS 9020. The NADIN concentrator local switching capabilities shall be provided for FDIO and NAS 9020 ports with the following features:

1. The destination address shall be specified in the message header field and shall contain a single explicit address only.

2. The source to destination routing scheme shall allow local switching of messages from FDIO to FDIO, FDIO to NAS 9020 and NAS 9020 to FDIO. Loop back (9020 to inputting 9020 and FDIO to inputting FDIO) shall be permitted.

3. Code, format and speed conversion shall be provided for locally switched traffic (reference Section 3.3.2.2.3.3).

4. The locally switched message is limited to a maximum length of 250 8-bit characters.

5. Traffic statistics shall be maintained for locally switched messages and periodically transferred to the switching center for recording in historical files.

6. If the destination station is not available to receive a locally switched message, this message may be forwarded to the switching center for further processing.

3.4.7.6.1.2 Full Local Switching Capability (Future Modification). The full local switching capability requires all of the following features:

1. The destination of locally switched messages shall be determined by:

   a. Explicit Address. Single or multiple explicit addresses, each one identifying a specific local addressee.

   b. Collective or Group Address. Each group address may represent one or more explicit local addresses. Up to 64 addresses may be contained within a group address including other group addresses. However, the result shall not exceed 512 explicit addresses.

   c. Implied Routing. In addition to the specified local addresses, the message shall be routed to one or more additional local addresses. The implied routing criteria shall be originating station and originating line.

2. The source to destination routing scheme shall allow for local switching of messages between preselected concentrator ports.

3. Code, format and speed conversion shall be provided for locally switched traffic.

4. The locally switched message shall not exceed 3700 8-bit characters.

5. Traffic statistics shall be maintained for locally switched messages and periodically transferred to the switching center for recording in historical files.

6. Appropriate buffer arrangements shall be provided for queueing locally switched messages for a minimum of 15 minutes when the concentrator is unable to deliver such messages. A message by message interleaving scheme should be provided to accommodate locally switched messages which encounter a destination port in a state of active receipt of messages from the switch.

3.4.7.7 Concentrator Terminal Back-up

When a concentrator-to-FDIO terminal circuit fault occurs, those terminals shall be reconnected as follows:

a. When a concentrator-terminal line fails; the FDIO terminal shall call the concentrator to reestablish communications.

b. Deleted.

3.4.7.8 Concentrator Failure

The concentrator is a critical element of NADIN. It shall, therefore, be provided with adequate back-up provisions to meet reliability criteria specified in this specification (see Section 3.7).

a. When the message switch determines that there is a concentrator failure, it shall:

1. Attempt to reload the concentrator operating programs.

2. Deleted.

3. Deleted.

b. Messages being sent from the switch to the concentrator at the time of failure shall be retransmitted with a "possible duplicate message" indicator except for messages to the NAS 9020 computer.

c. Deleted.

3.4.7.9 Concentrator Primary Power Failure

The concentrator shall be guarded against primary power failure by the following means:

a. The concentrator shall be fully compatible with Government-furnished Uninterruptible Power Supply Modules as covered by Specification FAA-E-2473. When the concentrator is powered by the above supply, it shall be capable of continuous, uninterrupted, nondegraded operation (also see Section 3.14.2).

b. A power-fail, automatic restart feature shall be provided within the concentrator if a power failure does occur. The power-fail feature shall provide for an orderly shutdown of the concentrator processor, such that when power is restored, the auto restart will return the concentrator to an operational status without the need for manual intervention.

3.4.7.10 Circuit Requirement

NADIN concentrators shall satisfy the circuit termination requirements specified in Appendix Z.

3.4.8 NADIN Modem Requirements

This portion of this specification defines the operational and functional requirements of modems used in the NADIN network. Modems specified herein span a range from low speed asynchronous operation through 9600 b/s synchronous transmission.

3.4.8.1 Classification

There are five classes of modems to be incorporated into the network. These classes are derived from their respective operating speeds and transmission modes. Further sub-categories are possible within any classification depending upon the options incorporated. Combinations of classes may be applicable. These categories are as follows:

Type I: 0-300 b/s; asynchronous; half/full duplex
Type II: 0-1800 b/s; asynchronous; full duplex
Type III: 2400 b/s; synchronous; full duplex
Type IV: 4800 b/s; synchronous; full duplex
Type V: 9600 b/s; synchronous; full duplex

3.4.8.2 Utilization

The five classes of modems used with NADIN shall be applied to three different areas of communication. These areas are categorized by their transmission rates, as well as functions. These areas are as follows:

a. Low-speed terminal to concentrator communication

b. Medium-speed communication

1. Terminal-to-concentrator
2. Concentrator-to-switch
3. Terminal-to-switch

c. Switch-to-switch-communication

3.4.8.3 Interface

All terminal and computer interfaces to the modems outlined in this specification shall conform to the electrical characteristics detailed in the applicable Interface Control Documents that are a part of this specification.

3.4.8.4 Rack Mounting

Modems located at the concentrator and switch sites shall be rack mountable in accordance with FAA Specification FAA-E-163. Modems located at a terminal need not conform with this requirement. Spare modems shall be mounted in the same rack with the operational modems to facilitate a modem back-up capability.

3.4.8.5 Patch Panel

A patch panel, or its equivalent, shall be provided at the concentrator and switching centers which allows for manual connection, disconnection, and switching of modems (see Sections 3.6.3.5 and 3.6.3.6).

3.4.8.5 Functional Requirements

Contractor-furnished modems shall meet the functional requirements of the following subsections.

3.4.8.6.1 Low-Speed Terminal to Concentrator Communication. Low-speed terminals that do not utilize current loop operation shall interface to their respective concentrator via Type I or Type II modems. These modems shall be capable of operating in both a multidrop and a point-to-point configuration. They shall be capable of both two- and four-wire operation over leased 3000-type dedicated circuits.

3.4.8.6.1.1 Carrier Loss. After a predetermined time not to exceed 10 seconds all low-speed asynchronous modems shall automatically disconnect if loss of carrier is detected.

3.4.8.6.1.2 Compatibility. To ensure compatibility between terminal sites, the modems shall maintain the following minimal standards:

a. Type I modems shall exhibit Bell series 100 compatibility.
b. Type II modems shall exhibit Bell series 202 compatibility.

3.4.8.6.1.3 Medium-Speed Concentrator Communications. Medium-speed modems of Type V are to be used for synchronous communication between switch and concentrator. Medium-speed modems of Types III and IV are to be used for synchronous communication between appropriate terminals and concentrator. These modems shall be capable of operating in both 2-way alternate and simultaneous modes over 4-wire facilities, in both multidrop and point-to-point configurations and as specified in the applicable Interface Control Documents (Appendices).

Type III and IV modems shall accept and transmit signals in accordance with FED-STD-1005 and proposed FED-STD-1006 respectively.

3.4.8.6.1.4 Data Rate Selection Switch. Deleted.

3.4.8.6.1.5 Equalization. The Type IV modems shall be provided with an automatic equalization procedure.

3.4.8.6.1.6 Modem Disconnection. It shall be possible for both Type III and IV modems to disconnect under the following conditions:

a. Automatically upon detection of carrier loss.
b. Upon disconnect signal from an associated modem.

3.4.3.6.1.7 Carrier Loss. After a predetermined time, not to exceed 10 seconds, a modem shall break communications if a loss of carrier is detected.

3.4.3.6.1.8 Disconnect on Signal. It shall be possible for both the concentrator and the switch to transmit a signal which will be interpreted by the receiving modem as a request to disconnect.

3.4.3.6.1.9 Compatibility. To ensure compatibility between sites operating at identical data rates, modems incorporated within the NADIN network shall maintain the following standards:

a. Type III modems, throughout the network, shall be capable of communication with any other Type III, 2400 bit/second modem.

b. Type IV modems, throughout the network, shall be capable of communication with any other Type IV, 4800 b/s modem.

3.4.3.6.1.10 Switch-to-Switch Communications. Medium-speed modems operating at 9600 b/s (Type V) will be used to handle all synchronous communications between switching centers. These links will be operated in a 4-wire, 2-way simultaneous point-to-point configuration over type 3002 conditioned dedicated circuits. (Also see applicable Interface Control Documents that form a part of this specification.)

3.4.8.6.1.11 Data Rate Selection Switch. A switch shall be provided on Type V modems to select a desired transmission rate (either 9600 or 4800).

3.4.8.6.1.12 Equalization. The Type V 9600 b/s modems shall be provided with an automatic equalization procedure.

3.4.8.6.1.13 Equalization Delays. (Deleted)

3.4.8.5.1.14 Modem Disconnection. It shall be possible for Type V modems to disconnect on the following conditions:

a. Automatically upon detection of carrier loss. (See Section 3.4.8.6.1.7.)
b. Upon disconnect signal from an associated modem. (See Section 3.4.8.6.1.8.)

3.4.8.6.1.15 Compatibility. To ensure compatibility between switching centers, all Type V modems must be completely compatible. Type V modems shall accept and transmit signals in accordance with CCITT V.29.

3.4.8.6.1.16 Dial Back-Up. When primary link failures occur, dial back-up shall be provided over the public switched network. Back-up shall be provided:

a. Between message switching centers;
b. Between a message switch and each NADIN concentrator;
c. For those terminals where traffic is deemed vital to NADIN operation.
d. For other users as indicated in Appendix Z.

See Section 3.3.2.9.5 and the applicable Interface Control Documents which form a part of this specification.

3.4.3.6.1.17 Modem Redundancy (Backbone). Adequate redundancy shall be provided by shelf spares and dial back up for each type of modem such that the overall reliability and maintainability of the concentrator and switch nodes are not degraded below the standards specified in Section 3.7.3.3.

3.4.9 Terminals

Terminals connected to NADIN may be Government or non-Government operated, owned or leased, and communicate in 5-level Baudot, 7-level ASCII code, and EBCDIC code (NAS 9020). Terminals therefore may be classed and are defined as follows for the initial implementation:

a. Low-speed, AFTN. These terminals operate in 5-level or 7-level code and employ procedures and formats described in Section 3.3.4.1.2. Where controlled circuits are employed in 5-level code, the U.S. provides 83B3 line control, modified to employ ZCZC as Start of Message (SOM) and NNNN as End of Message (EOM).

b. Low-speed, FAA. These terminals are M-28 teletypewriters modified to comply with the FAA polling and addressing procedures defined in Section 3.3.4.1.1. Continued use of these terminals will be made following NADIN implementation.

c. Low-speed, non-FAA. These terminals are M-28, M-33, M-35, M-37, and M43 or equivalent, teletypewriters provided by the user (owned or leased) and shall employ 83B3 or 85A2 link control.

d. Medium-speed, FAA. These terminals will be available for connection to NADIN at the time of implementation at certain FSS locations and at each ARTCC, and shall comply with FAA Specification FAA-E-2586. They shall operate under ANSI X3.28 subcategory 2.4, 2.5 or 2.7, A2, A4 or B1 protocol, and use the NADIN message format as specified in this specification.

e. Processors such as AWP, NAS 9020 computer and others as listed in Appendix Z.

3.4.9.1 Terminal Failure

A terminal will not generally be provided with back-up provisions in case of failure.

a. When a terminal is determined to have failed, the concentrator shall:

1. Notify the message switch requesting it to hold subsequent messages until further notified.

2. Continue polling the terminal and sending test messages (except for the NAS 9020 computer) until the terminal responds.

b. Messages interrupted by a terminal failure will be handled by the provisions of Section 3.3.2.11.1.3.

c. Once a terminal other than the NAS 9020 has been restored to operational status:

1. It shall respond to polls, causing the concentrator to notify the message switch of the new status.

2. It shall retransmit messages not previously acknowledged by the message switch.

d. Once the NAS 9020 computer has recovered to operational status, it shall utilize the procedures of Appendix F.

3.4.9.2 Terminal Back-Up

When a concentrator-to-terminal circuit fault or concentrator node fault occurs, those terminals equipped with a dial back-up capability shall be reconnected as follows:

a. When a concentrator-terminal line fails, the FDIO terminal shall call the concentrator to reestablish communications.

b. Deleted.

c. When an FDIO terminal has established a dial in connection to the concentrator, local switching will not be available for traffic to or from the dialed in FDIO terminal. In this case all traffic to or from the dialed in FDIO terminal will be forwarded to the switching center for processing.

3.4.10 Training

The contractor shall provide a training course for FAA personnel on all contractor furnished equipment such that FAA personnel may assume all maintenance, operation, and programming responsibility upon the conclusion of the contractor's support service in accordance with the terms and schedule of the contract, and FAA-E-2552.

3.5 Software Requirements

3.5.1 Scope

The Computer Program Subsystem consists of the software required to install, test, operate, and maintain the NADIN system. The contractor shall provide all necessary qualified personnel, facilities, materials, and services, except as otherwise provided herein, to design, produce, install, test, and document the National Airspace Data Interchange Network (NADIN) Computer Program Subsystem. Any feature or item necessary for proper operation in accordance with the requirements of the

contract shall be incorporated even though that item or feature may not specifically be described herein. In addition, any special computer programs and associated computer program documentation required for training FAA technicians, system analysts, and computer programmers shall be provided if ordered by the Government. The NADIN Computer Program Subsystem encompasses the switching centers and concentrators as applicable and shall include:

a. Operational Program Component (Section 3.5.3)
b. Nonoperational Program Component (Section 3.5.4)

1. Switching Center Utility Programs (Section 3.5.4.1)
2. Concentrator Utility Programs (Section 3.5.4.2)
3. Offline Maintenance Programs (Section 3.5.4.3)
4. Support Computer Program Component (Section 3.5.4.4)

c. NADIN Computer Program Subsystem Tapes (Section 3.5.5.1)
d. Documentation (Section 3.5.5)
e. Software Support (Section 3.5.6)

3.5.2 Computer Program Subsystem Design

Design of the program subsystem shall provide for ease of human intervention for site adaptation and for program maintenance and modification, with appropriate provisions for prompting, and editing of programmer input statement and recovery from user input errors. Particular attention shall be given to coding for ease of understanding by FAA programming personnel. Programs shall be designed in accordance with modern techniques, and shall be well structured and internally documented to promote rapid comprehension. The programs shall be table based, where appropriate, for ease of operational modifications, and shall be modular to an appropriate level to accommodate the addition of new functions without undue difficulty or operational impairment as the new functions are defined and added. Hence, the initial NADIN Computer Program Subsystem is to be considered the base which may be expanded to meet future requirements. The design shall be conducted by the contractor to include the definition of the program organization and design necessary to meet this base requirement. The resulting design shall be documented in the Computer Program Functional Specification (CPFS), Section 3.5.2.1.1, and the Program Design Specification (PDS), Section 3.5.2.1.2.

3.5.2.1 Computer Program Subsystem Design Data

The contractor shall, within the periods specified below, provide one reproducible and eight copies of all data required hereunder to be submitted for design review, including the items specified in the subsections below, to the FAA Contract Officer (CO) for review and approval as specified in Section 3.8.11. The design data submission shall be organized to reflect the contractor's approach to the provision of the computer programs in accordance with specified requirements. This submission of design data shall not be used to propose modifications or alternates to details of the software requirements or a change in scope of the contract. The design data referenced below shall include all computer programs to be produced by the contractor under the terms of the contract, as detailed by this specification and any addenda thereto.

3.5.2.1.1 Computer Program Functional Specification. The contractor shall provide a Computer Program Functional Specification (CPFS) that describes the organization and functional design of the NADIN Computer Program Subsystem. This document shall identify the overall functional design and show the relationship between the operational requirements and the design approach to include performance parameters, sources and types of inputs, destinations and types of outputs, data base requirements and descriptions of each data base, and all human interactions with the system. Allocation of functions to computer and human resources shall be identified as well as the expected resource utilization. The general description of the functional design shall include an overall functional logic diagram and a data flow diagram, the latter to include all input and output points and secondary storage references. The CPFS shall include the contractor's philosophy of system operation, monitoring, and control for each type of node as well as for the entire network as it affects each program component. The CPFS shall be organized by computer program components. Within each computer program component, the CPFS shall include a description of the functions, operations, and organization of the program component, including an outline of each computer subprogram.

The design activity shall subdivide each computer program function into subprograms and identify and describe the tasks that comprise each subprogram. For each subprogram, the contractor shall provide in the CPFS the requirements of the data base including description of the data, allocation of the storage among the computer storage devices, methodology of input, output, and buffering processes, and types of processing and responses to each type. Estimates of computer processing time for each subprogram shall be included, as well as the storage required both for the computer instructions and pertinent tables involved on a subprogram basis. The contractor shall identify all requirements in the area of tape and disk configuration, card reader and punch units, high speed printers, and other peripheral units.

3.5.2.1.2 Program Design Specification (PDS). Program Design Specification translates the operational program functional requirements established in the CPFS into computer program tasks expressed in terms used by the programming profession. The PDS shall be organized by program component and shall include the following information where applicable:

a. A general description of the overall structure and functions of the entire computer program subsystem to be produced.

b. High level flow charts of the operations to be performed by the entire computer program subsystem.

c. A delineation in the form of flow charts and descriptions of the program subsystem into functional entities or program units (computer program components, subprograms, tasks, and program modules). Each delineation shall show the processing being performed, the sequence of operations, and the major decision points. This process shall follow the program hierarchy down to the lowest program unit.

d. A functional description of each program unit.

e. The estimated storage requirements for each program unit, its priority level and whether it is normally core or secondary storage resident.

f. A description of the input tables and data required for the operation of each program unit.

g. A description of the output tables and data to be generated by each program unit.

h. An identification of the tables and items with each table that comprise the data base for the entire NADIN system. This shall include the data hierarchy, interrelationships of data files, description of all file structures and all access to each file.

i. An estimate of the operating time for each program unit.

j. A description of the linkages between program units.

k. References to the NADIN Computer Program Functional Specification.

l. Design standards and conventions to include flow charting, names and labels, interfacing, system macros, and input and output message formats.

m. Coding standards and conventions to include languages, prohibited coding practices, required coding practices, and recommended coding practices.

3.5.2.2 Operating System

All computer programs shall operate under control of a common operating system. A flexible common operating system shall schedule, control, and sequence appropriate programs and shall provide necessary linkage between computer programs and the NADIN hardware. If more than one distinct operating system is necessary, all programs comprising the Operational Program Component shall operate under an Operational Operating System, Section 3.5.3.1; and programs of the Nonoperational Program Component shall operate under a Nonoperational Operating System, Section 3.5.4.

3.5.2.3 Compatibility

The concentrator elements shall be compatible with the message switch, allowing concentrator software to be developed and executed on the message switch. All computer programs resident within the message switches as well as the concentrators shall have the following characteristics:

a. Computer programs located at the switching centers shall be identical in as much as they are compatible and capable of running on either switch.

b. The concentrator computer programs shall be compatible with the other concentrators and the switches.

c. The concentrator programs shall be capable of running on the message switch.

d. The message switch shall maintain a copy of all concentrator computer programs.

3.5.3 Operational Program Component

The Operational Program Component consists of those real-time programs at both switches and all concentrators required to perform traffic processing, communication data recording, online maintenance, system startup and system recovery. The Operational Program Component described below shall comply with all of the functions and requirements of this specification.

3.5.3.1 Operational Program Component Operating System Requirements

A flexible operating system (see Section 3.5.2.2) shall be provided, the characteristics of which can be fixed at system generation by selection of desired values for optional parameters.

3.5.3.1.1 Multiprogramming/Multiprocessing Operation for Single Processor Systems. The operating system shall provide for multiprogramming operations: a programming technique in a computer system in which two or more programs are operated on a time-sharing basis, usually under control of a monitor which determines when execution of one program stops and another begins. For a single processor system, several tasks may be present in storage at the same time and be performed concurrently even though only one task is being executed at a given moment. For multiprocessing systems, program tasks may be logically and/or functionally divided among a number of independent CPUs, with the programming tasks being simultaneously executed and coordinated among the processors.

3.5.3.1.2 Multipriority Requirements. The operating system shall provide, as a minimum, four levels of execution priorities. Tasks will be scheduled according to their respective priorities. These priorities will be initially assigned during system generation but may be modified by the operating system as conditions dictate.

3.5.3.1.3 I/O Handlers. As a part of the operating system the contractor shall supply all programs necessary to interface the NADIN switch to its local peripheral units and to the communications circuits specified in this document. As a minimum these programs shall be capable of processing all I/O requests on all peripheral devices and all circuits according to procedures and formats described herein. If a local peripheral failure occurs, the I/O handlers shall be capable of performing failure recovery as applicable. Where automatic error recovery is possible, the failure recovery operation shall not be attempted until a selected number of error recovery tries is reached.

3.5.3.1.4 Operational Control. The control, timing, and sequencing of the operational program routines including the online maintenance program shall be provided in a manner consistent with Sections 3.5.3.1.1, 3.5.3.1.2 and 3.5.3.1.3. These routines shall assure effective operation of the NADIN upon completion of system startup and after system recovery from a failure. As a minimum, this operation shall include the following functions:

a. Monitor all circuits and poll multipoint circuits.

b. Service interrupts.

c. Return control to proper point in program after interrupt processing.

d. Schedule tasks.

e. Control the action of input/output routines.

f. Reconfigure the system automatically in emergency situations as well as under operator actions.

g. Manage primary and secondary storage resources.

h. Control and regulate the operational application subprograms to assure orderly, normal processing and prevent overloads in emergency conditions.

3.5.3.1.5 System Start-Up. System start-up routines shall assume control of the NADIN until start-up is complete. These routines shall be entered into main memory by an operator-initiated loading routine. The system start-up routines shall load appropriate computer programs from removable secondary storage and also load data tables from secondary storage into appropriate storage elements of the NADIN, with working storage reserved and initialized. Upon completion of system start-up, control shall be transferred to the operational control routines of the operating system. The transfer shall be indicated by a printout at the supervisor's console and other appropriate locations (see Section 3.3.2.9.1).

3.5.3.1.6 System Recovery. System recovery routines shall be used by the NADIN to regain full operational capability after a period of degraded operation. These routines shall assume control of the appropriate segment of NADIN upon the initiation of the system recovery by either the operational control routines or as directed by a manual entry from the supervisory console. The recovery routines shall perform all functions to resume normal operation such as retrieval of required messages from reference storage and reestablishment of recovered messages in queues. In the event of malfunction, the recovery routines shall initiate requests for retransmission to the originators of irretrievable messages in accordance with priority and discard lists. System recovery routines shall permit NADIN to change to a mode of operation where one or more hardware elements have failed and have been switched offline. The recovery of old messages shall proceed simultaneously with the acceptance and processing of new messages (see Section 3.3.2.9.3).

3.5.3.2 Message Switch Operational Programs

In conjunction with requirements of Operational Control, Section 3.5.3.1.4; System Start-up, Section 3.5.3.1.5; and System Recovery, Section 3.5.3.1.6, the message switch operational programs shall:

a. Process messages based upon a minimum of a four level priority structure.

b. Provide an intercept function for diagnosing and acting upon messages that do not conform to an expected format.

c. Provide network control functions based upon the current state of NADIN traffic.

d. Provide a monitor for the operational programs and related components for possible malfunctions, and provide back-up procedures for these malfunctions to ensure a high degree of reliability and availability (see Sections 3.6 and 3.7).

e. Maintain traffic statistic records to be used to generate reports regarding NADIN efficiency and traffic flow (see Section 3.3.2.6.5).

3.5.3.2.1 Online Maintenance. The online maintenance function shall be capable of detecting an element hardware or software failure. If an element failure is detected, the online maintenance function shall cause the equipment complex to be automatically reconfigured to exclude the failed element from further operational use. A redundant online element is then automatically assigned the tasks of the failed element. No manual intervention of any kind shall be required. If no redundant element exists, the fail-soft philosophy applies. If an element is in a fault condition, i.e., operable but with intermittent errors (see Section 3.7.2.4(a)) or with degraded performance or capability, the faulty condition shall be indicated at the supervisory position and, upon receipt of an appropriate command from the supervisory position, the faulted element shall be removed from the system subject to the same conditions as a failed element. For failed or faulty

elements, the system shall trap relevant information about the error condition and make the information available to maintenance technicians and programmers via error printouts, memory dumps, and secondary storage dumps (see Section 3.6.3.3.1). Upon completing the requirements of Section 3.6.3.1.2, the repaired element shall be returnable to the online system without affecting or harming the operational system.

3.5.3.2.2 (EX) Online Utilities. Deleted.

3.5.3.3 Concentrator Operational Programs

In conjunction with requirements of Operational Control (Section 3.5.3.1.4), System Start-up (Section 3.5.3.1.5), and System Recovery (3.5.3.1.6), the concentrator operational programs shall provide the required buffering, conversions, and communication functions necessary to collect messages from terminals, to perform local switching (see Section 3.4.7.6.1) and to distribute messages received from the message switch. The concentrator shall also have the capability to gather statistical data concerning locally switched traffic as specified in Section 3.4.7.6.1.1. The concentrator shall have the capability of monitoring message activity for error conditions, such as modem or circuit faults, and provide alternative actions based upon such monitoring checks. All concentrator operational programs shall operate on a real-time basis, and shall be entirely stored in the concentrator memory.

3.5.3.3.1 General. NADIN concentrator operational programs shall operate online in a real-time message forwarding environment. These programs shall operate in conjunction with the concentrator hardware to provide interfacing between otherwise incompatible communication ports, monitor the concentrator's own status, and handle the specified traffic requirements (see Appendix Z).

3.5.3.3.1.1 Concentrator Operating System. The contractor shall supply a concentrator operating system that provides the control and timing of the functions outlined in this specification. As a minimum, it shall perform the following functions:

a. Scan all circuits and poll as appropriate.
b. Schedule tasks.
c. Control the action of input/output routines.
d. Reconfigure the system automatically in emergency conditions.
e. Service requests from the message switching center.
f. Schedule online maintenance.

3.5.3.3.1.2 Concentrator Start-Up. The start-up routine shall load all concentrator software via down line load from the switch into the concentrator memory. Upon completion of these procedures, the start-up routine shall transfer control to the operational control routines.

3.5.3.3.1.3 Concentrator Recovery Routines. Recovery routines shall exist within the concentrator for use when a failure forces the concentrator into a degraded or halted mode. Recovery routines shall be capable of, but not limited to, downline loading of the concentrator from a message switch.

3.5.3.3.1.4 Online Maintenance. The concentrator online maintenance function shall be identical with that function in the switch (see Section 3.5.3.2.1).

3.5.3.3.1.5 (EX) Online Utilities. Deleted.

3.5.4 Nonoperational Program Component

The nonoperational (i.e., non-real-time) program component of the Computer Program Subsystem encompasses matters of utility, maintenance, and support within the NADIN framework. The nonoperational program component shall, as required herein, operate on the NADIN equipment under the control of the common operating system (see Section 3.5.2.2). The nonoperational program component shall be a multiprogramming operating system that as a minimum meets the requirements of Sections 3.5.3.1.1 and 3.5.3.1.3, and supports all the nonoperational programs required by this specification. The utility programs shall provide the tools necessary for the production, modification, and maintenance of computer programs of the NADIN Computer Program Subsystem. The maintenance programs shall provide the diagnostic and check-out programs for use with established maintenance and certification procedures. The support programs shall provide for the various phases of system implementation including factory acceptance tests, factory acceptance exercise, onsite exercise, and cutover. The nonoperational program component shall be provided as applicable to the switching center and concentrator facilities. The contractor shall provide sufficient equipment(s) to permit the offline isolation of the necessary equipment to fulfill each of the requirements of the nonoperational program component, while simultaneously performing all the online operational and maintenance requirements, without degrading or jeopardizing the online system. It is desirable that the Government be able to combine offline equipment and online redundant elements into functional configurations that will enhance the capability of the offline system, but still permit the online system to seize control of the online redundant elements. The contractor shall not preclude the concurrent operation of more than one program (e.g., traffic analysis and library editing, assembly and media transfer) under the control of the multiprogramming operating system providing there are sufficient resources available to the operating system. The contractor shall submit, as part of the CPFS, a list of the resources required to meet each of the requirements stated in Section 3.5.4 and how these resources will be obtained from the contractor provided total system equipment.

3.5.4.1 Switching Center Utility Programs

A complete set of switching center utility programs shall be provided. These utility programs shall include, but not be limited to, the following:

3.5.4.1.1 Software Generation Package. The contractor shall provide a complete, documented software generation package adequate to enable FAA programming personnel to modify and extend the software subsystem. The package shall be capable of being executed on offline elements of the NADIN switch and shall produce relocatable code for it from appropriate source code. The package shall support and include control statements to permit decimal-to-binary and binary-to-decimal conversions, acceptance of alphanumeric data storage allocating input and output, and source statement level documentation. A working assembler and macro assembler for producing machine language code for the NADIN switch from an input of symbolic machine oriented source statements is required as a minimum part of this package. If parts of the software subsystem use a higher level language, the appropriate compilers for use in developing, extending, or modifying such parts must be provided as part of this package.

3.5.4.1.2 Loaders. These programs shall be capable of loading object programs into main storage and shall be self-loading.

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3.5.4.1.3 Dumps. Dump programs shall be supplied for transferring the contents of main and secondary storage to magnetic media and high speed printers. These dumps shall be displayed in either hexadecimal or octal code and its alphanumeric translation.

3.5.4.1.4 (E X) Program Debugging Aids. Deleted.

3.5.4.1.5 Cross Reference Programs. The contractor shall provide a program designed to show all references to each program label in the message switch and concentrator software.

3.5.4.1.6 (E X) Memory and Mass Storage Inspection Routines. Deleted.

3.5.4.1.7 Media Transfer. The contractor shall provide routines that will transfer data from one medium (e.g., card, tape, secondary storage) to another medium.

3.5.4.1.8 Table Build. The contractor shall provide computer software to facilitate the maintenance of NADIN table data. Online changes to table data shall be supported and shall be effected via a reasonable operator command repertoire. Reasonable offline capabilities to define, dimension, integrate, and fill tables shall be provided. Additionally, such software shall provide for the generation of reasonably formatted switching center and concentrator operational support printouts. Offline capabilities shall also include the same command repertoire to effect changes to table data as provided in the online mode.

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3.5.4.1.8.1 (E X) Table-Build Input. Deleted.

3.5.4.1.8.2 (E X) Table-Build Format Compatibility. Deleted.

3.5.4.1.8.3 (E X) Table-Build Statement Sequence. Deleted.

3.5.4.1.8.4 (E X) Table-Build Edit and Reasonableness Criteria. Deleted.

3.5.4.1.8.5 (EX) Table-Build Statement Hierarchy. Deleted.

3.5.4.1.8.6 (EX) Table-Build Primary and Backup Statements. Deleted.

3.5.4.1.8.7 (EX) Table-Build Command and Responses. Deleted.

3.5.4.1.8.7.1 (EX) Online and Offline Command Sequence. Deleted.

3.5.4.1.8.7.2 (EX) Internal Data Structure Commands. Deleted.

3.5.4.1.8.7.3 (EX) Table-Build Response Repertoire. Deleted.

3.5.4.1.8.8 (EX) Table-Build Report. Deleted.

3.5.4.1.8.9 (EX) Table Directory. Deleted.

3.5.4.1.8.10 System Data. Offline table-build software shall provide for the generation and maintenance of message switch and concentrator table data. The contractor shall specify how the following shall be accommodated:

a. Generation of message switch machine loadable system magnetic devices.

b. Deleted.

c. Procedures for incorporation of online table-build changes from message switch to appropriate concentrator.

d. Procedures for maintenance of concentrator tables after an online change has been incorporated into concentrator tables. This shall include consideration of online concentrator table changes and actions required after a concentrator failure.

3.5.4.1.9 Cross-Assembler. The contractor shall state whether a cross-assembler is available as off-the-shelf software and, if it is available, what equipment (vendor and model), configuration, and capacity it requires, under what operating systems it runs, and any constraints or limitations. If ordered by the Government, the contractor shall supply the cross-assemblers.

3.5.4.1.10 (EX) Image Search and Compare. Deleted.

3.5.4.1.11 Library Editing. The contractor shall provide a capability to edit a library residing on secondary storage or magnetic tape. This editing shall be capable of adding, deleting, inserting, listing, replacing, renaming, and reordering logical sets of data within the library (e.g., source program and object program modules). The library system shall permit maintenance of files for each switching center and for each concentrator node in the network and shall be expandable to accommodate additional switching centers and concentrator sites.

3.5.4.1.12 (EX) File Compare. Deleted.

3.5.4.2 Concentrator Utility Programs

A set of concentrator utility programs shall be provided. This set shall include, but not be limited to, the following programs.

3.5.4.2.1 Software Generation Package. The contractor shall provide a software generation package for the concentrator consistent with the compatibility requirements in Section 3.5.2.3 and applicable functions of Section 3.5.4.1.1. Furthermore, the concentrator assembler shall be fully compatible with the message switch assembler and shall execute on the message switch hardware.

3.5.4.2.2 Loaders. The contractor shall supply a loader program or programs, as necessary, capable of loading object code produced by the software generation package (see Section 3.5.4.2.1). As a minimum, the program must be loadable by the following means:

a. Down-line loading of code supplied over communication facilities from the switching center.

b. Deleted.

c. Deleted.

The loader programs shall be self-loading.

3.5.4.2.3 Dumps. The contractor shall supply routines capable of dumping all or select portions of the concentrator main memory to either a local terminal or a message switch center. The dump routines need not be continuously core resident and may be remotely loaded from the message switch.

3.5.4.3 Offline Maintenance Programs

Offline maintenance programs are to be provided for the switching center and concentrator facilities, and are to be under control of the Nonoperational Operating System (see Section 3.5.4). These programs shall consist of a variety of comprehensive routines that are to be utilized in conjunction with established maintenance procedures when all or part of the NADIN switch and concentrator is operating offline. These programs shall include routines to test for, detect, and isolate faults in all the NADIN switch and concentrator equipment units or elements, and to perform the preventive and routine maintenance functions. These programs shall be capable of being used in a routine fashion for offline maintenance at any time, and, by supervisory position command, of providing summary reports and detailed reports of the status of each element or device tested. The reports shall appear on hard copy devices as directed by command from the supervisory position. They shall be designed for use by FAA maintenance personnel trained in accordance with the requirements of this specification and the contract schedule.

3.5.4.4 Support Computer Program Component

The Support Computer Program Component consists of those programs required for the various phases of testing and system implementation (e.g., factory testing, hardware installation and checkout, computer program shakedown, system shakedown, and operational readiness demonstration), and those that are to be used for system operation, management, and engineering support during follow-on system operation (e.g., DR&A programs necessary for statistics recording analysis - see Sections 3.5.3.2(e) and 3.3.2.6). This includes computer programs for Programmed Equipment Checkout (PECO), Data Reduction and Analysis (DR&A) programs, special purpose computer programs for program shakedown, system shakedown, and operations changeover, and system performance analysis programs.

3.5.4.4.1 Programmed Equipment Checkout (PECO) Programs. Programmed Equipment Checkout (PECO) programs shall be provided to meet the hardware test requirements of this specification. As a minimum, these programs shall be designed to test the NADIN interfaces as well as test functional capabilities of the hardware subsystems. Where practical, the programs shall fully test the error logic employed. The nonoperational operating system shall permit PECO programs to be executed in any combination in a flexible and modular configuration.

3.5.4.4.2 Data Reduction and Analysis (DR&A) Programs. Data reduction and analysis programs shall provide a data processing system that is flexible, expandable, and as automatic as possible with respect to its operation. These programs shall fulfill requirements of DR&A during all phases of hardware testing and integration, program shakedown, system shakedown, and operations changeover and provide a base with a capability to add programs as additional user requirements are identified.

3.5.4.4.3 Special Purpose Programs. Special purpose programs shall be provided as required to support testing in addition to the PECO, offline maintenance, and DR&A programs.

3.5.4.4.4 (EX) System Performance Analysis Programs. Deleted.

3.5.4.4.4.1 (EX) System Performance Data. Deleted.

3.5.4.4.4.2 (EX) System Performance Analysis. Deleted.

3.5.4.4.4.3 (EX) System Modeling. Deleted.

3.5.4.4.4.4 This section has been renumbered. See Section 3.5.4.4.5.

3.5.4.4.5 System and Software Checkout. The contractor shall provide the capability, with hardware and software, to permit the Government to debug and test existing, modified, or newly designed programs, routines, or modules of any program component of the NADIN Computer Program Subsystem at both message switching centers. The contractor shall provide hardware interlocks and software safeguards, without hindering or constraining the Government programmers, to prevent unintentional interruption, malfunction, commingling of instructions or data, or any type of conflict between the online active system and the checkout of software on the offline system with or without online redundant elements (see Section 3.6.3.2.3).

3.5.5 Deliverable Items

The contractor shall provide the following software and associated documentation in the quantities and according to the schedules specified in the contract. The contractor shall furnish Software Manuals/Handbooks (Sections 3.5.5.3, 3.5.5.4, 3.5.5.5, 3.5.5.6) prepared in a careful and workman-like manner in accordance with best practices (consistent with intended use) as applied to similar manuals normally furnished for commerical equipment. Documentation review and approval shall be made in accordance with Sections 3.8.10 and 3.8.11.

3.5.5.1 NADIN Computer Program Subsystem Tapes

The NADIN computer program subsystems shall be delivered on one or more magnetic tapes with supporting hard copy as determined by the contractor's design to be most beneficial to the FAA. This delivery shall consist of master object tape, master symbolic tape, subprogram listings and data table listings. If a medium other than magnetic tape is more appropriate to the contractor's design, he may, with approval of the CO, substitute such a medium for the magnetic tape otherwise required. The contractor shall organize the material delivered under this requirement in such a way that facilitates its handling and use by the FAA.

3.5.5.2 Software Design Data

The Software Design Data (SDD) shall be developed and maintained concurrently with the design, coding, and test activity of the entire computer program subsystem. It shall be available for review and monitoring by the Government upon request. Modifications made to the program shall be reflected in changes to the delivered SDD. The SDD shall be organized to follow the CPFS and the PDS and shall include, as a minimum, the following:

a. A complete technical description of the computer program structure and functions, including all interface points with the operating system.

b. A graphic portrayal of the operations performed by the computer program subsystem. This shall be done by a series of flow charts which depict the processing being performed, the sequence of operations, and the decision points. The contractor shall provide program design level flow charts which show the program design of each NADIN software and firmware component in the operational on-line and off-line systems. These flow charts shall represent that software and firmware located in the switching centers and concentrators. These flow charts shall delineate the relationships within and between the NADIN program units e.g., computer program components, subprograms, tasks and/or program modules. Each delineation shall show the processing to be performed, the sequence of operations, major decision points, error paths and internal and external interfaces to other software components including any files, tables, directories, etc., in the database. Names and labels shall be consistent with all other NADIN documentation including the SDD and program listings. These program design level flow chart entities shall be cross referenced to the software components described in the SDD..

c. Relationships between tables.

d. A summary of any known or anticipated limitations, restrictions, and constraints which apply to the program component, e.g., timing requirements, limitations of algorithms and formulas used, limits of input and output data, associated error correction sensing, and the error checks programmed into the routines.

e. The contractor may use hierarchy-input-process-output (HIPO) documentation in lieu of flow charting wherever flow charting is specified; however, the degree of detail shall remain as specified regardless of the documentation system.

3.5.5.3 System Operator's Manual

The System Operator's Manual shall describe procedures to enable operational personnel to load programs, operate the programs, to intervene in the program's operation, and to restart the programs. The manual must include the following, as a minimum:

a. Method of loading programs both at start-up and startover.

b. Input parameters required to commence program subsystem operation.

c. A listing and a brief explanation of each message that can be input at the operational consoles.

d. A listing and a brief explanation of each message that can be output at the operational consoles.

e. Associated actions that can be taken as a result of (d) above.

f. A list of programmed halts.

g. A list of logical device assignments.

h. A method of cross-referencing console printouts to provide rapid access to the corresponding information in the System Operator's Manual.

i. Organization to correspond with each of the functional positions specified, e.g., computer console operator, intercept operator, maintenance, and supervision.

3.5.5.4 System User's Manual

The user's manual provides the information needed to enable the user to control and operate each computer program. The user's manual shall be organized into volumes based on the program or programs described. The introduction to each volume shall give the purpose, scope, basic organization of the volume, and general background information to the program or programs described therein. A complete list of terms and abbreviations used in the document shall be provided. Also, it shall provide a general program description plus description of the environment and use. A general description of program requirements and constraints shall be included, as appropriate. The user's manual shall contain detailed description of:

a. Input formats and devices.
b. Output formats and devices.
c. Control and diagnostic messages.
d. Options and their control.
e. Service requests available.
f. Calling sequence.
g. Start-up and startover procedures.
h. Job control procedues.

3.5.5.5 Operating System Manual

The Operating System Manual describes the services provided by the software subsystem operational operating system and, if applicable, the nonoperational operating systems, and the interface requirements for using the service, necessary to computer programmers in designing programs which will operate under the applicable operating system. If appropriate, the manual shall be organized into volumes based on the operating system described. The introduction of each volume shall give the purpose of the document and specify the scope of its application. It shall include a general description of the operating system in the context of its operating environment and shall list the types of services it provides. The relationship of the Operating System Manual to other system documents shall be discussed and documents providing additional operating system design data and operating information identified. As a minimum, the manual shall contain a detailed description of:

a. Service requests available.
b. Call sequences.
c. Start-up and startover procedures.
d. Job control procedures.

3.5.5.6 Programmer's Reference Manual

A Programmer's Reference Manual which includes a description of the computer instructions, commands, and orders used in a operational machine program shall be provided. The manual shall also include, but not be limited to, information on instruction timing, use of index registers, logical and arithmetic operations, data transmissions, input and output operations, use of indicator lights and branch switches, and other such programmer reference material.

3.5.5.7 Peripheral Equipment Reference Manual

The contractor shall provide a Peripheral Equipment Reference Manual containing the following information, where applicable, for each type of peripheral device supplied:

a. General technical description of equipment.
b. Performance criteria including capacity and access time.
c. Physical and logical data structure.
d. Type of controller and maximum number of devices per controller.
e. Detailed explanation of all status information including recommended software action.
f. All input and output commands and tests relevant to that peripheral device.

3.5.5.8 Table Structure Manual

The contractor shall supply a manual containing a pictorial layout of all tables, files, records, and other data structures to include the symbolic reference to each hierarchic level, explanation of the function, and all written references.

3.5.6 Software Support

If ordered by the Government, the contractor shall provide qualified personnel to support software maintenance and modification at selected sites, following NADIN operational changeover. These services shall be performed at Government designated field site or sites not to exceed a period of one year following NADIN operational changeover.

3.6 System Maintenance Requirements

The NADIN system shall include provisions for the efficient maintenance of the system; such that availability, reliability, maintainability, and performance requirements specified herein can be achieved. Maintenance features of the switching centers, concentrators, and their associated peripheral and ancillary equipment and subsystems shall be integrated in a modular manner so as to minimize the time required for fault detection, isolation, testing, repair, and service restoration by making maximum use of current automation techiques and centralized maintenance control.

3.6.1 Scope

The NADIN shall be designed to enable the preservation and timely restoration of the NADIN capability with a minimum of down time and a minimum of human involvement. Proven, existing equipment and techniques shall be used to the greatest extent possible. Hardware, software, and test implementation requirements and desirable features that support this are described below.

3.6.2 Maintenance Definitions

The following maintenance definitions shall apply.

3.6.2.1 Element Status

In order to state the requirements of the NADIN Maintenance System it is necessary to define all elements by their current status in the system. Equipment status has been broken down into the following categories. Their definitions follow:

3.6.2.1.1 Online Active Elements. Those hardware elements that are actively engaged in the routine processing of traffic.

3.6.2.1.2 Online Redundant Elements. Those hardware elements not presently being used to perform a communication function, but which would be available for use by the operational system within the 30-second recovery requirements specified in Section 3.7.4.1.

3.6.2.1.3 Offline Elements. Those hardware elements not presently being used to perform a communication function and which would not be available for use by the operational NADIN system within the 30-second recovery requirement specified in Section 3.7.4.1. These elements may be used to perform an offline function such as scheduled or unscheduled maintenance. Manual intervention may be required to place these elements online. The actual time before these elements could be available to the online system depends upon the hardware configuration chosen.

3.6.2.1.4 Inactive Elements. Those hardware elements not available to the operational system. The reason for nonavailability might be due to component failure, marginal checking (preventive maintanance), or element power off.

3.6.2.2 Types of Maintenance

For the purpose of this discussion, the maintenance function will be classified as either "online" or "offline". Online maintenance is performed only on online active or redundant elements. Offline maintenance is generally performed only on offline elements. The sole exception to this rule is in the case of a two-processor configuration, in which spare capability in the online processor can be used to perform diagnostics on the other

processor after it has failed. Such a procedure is allowable only to the extent that it has no effect on the traffic handling functions and capacity of the online processor. In a hardware configuration where all elements (except failed elements) are available within a 30-second recovery period, the offline maintenance function, as defined here, may be run on a combination of online redundant and offline elements.

3.6.2.2.1 Online Maintenance. Although maintenance is generally considered as an offline function, being performed on offline elements, it is useful in this discussion to define certain operational functions as online maintenance. These functions include programs to maintain and report on current element status, to detect errors, to diagnose and print out limited information on errors for maintenance personnel (see Section 3.6.3.3.1).

3.6.2.2.2 Offline Maintenance. The bulk of the maintenance function shall generally be performed on the offline elements. Offline maintenance is generally classified as either scheduled maintenance or unscheduled maintenance. A further breakdown follows.

3.6.2.2.2.1 Scheduled Maintenance. Scheduled maintenance includes preventive maintenance, routine maintenance, and corrective maintenance.

a. Preventive Maintenance. Preventive maintenance can be defined as planned periodic marginal and functional testing of the NADIN elements and components. Preventive maintenance techniques (e.g., voltage or clock timing marginal checks) are used to detect marginal components (e.g., that are due to aging or drift) at the test bench and for repair and maintenance of mechnical and electromechnical devices.

b. Routine Maintenance. Routine maintenance consists of the repair of failed components (e.g., printed circuit boards) at the test bench and repair and maintenance of mechnical and electromechanical devices.

c. Corrective Maintenance of Known Failures. Corrective maintenance on failed elements can often be scheduled for a later work shift to take advantage of superior maintenance capability or a later time when there is a low traffic demand. During periods of low traffic demand, additional elements may be available to aid in the repair and test of the failed element. Such maintenance can be classified as scheduled corrective maintenance.

3.6.2.2.2.2 Unscheduled Maintenance. Unscheduled maintenance consists of maintenance required immediately following a failure found by the online maintenance function and that cannot be scheduled for a later time (e.g., total system failure, element failure where no further redundant element of that type remains for use by the operational system). Normally, single element failures occurring during peak traffic loads would be scheduled for repair during a low-load period (i.e., scheduled corrective maintenance) or handled by offline test equipment (see Section 3.6.3.4).

3.6.3 Maintenance Requirements

These paragraphs specify maintenance requirements and reference other pertinent sections.

3.6.3.1 Maintenance Philosophy

The detailed maintenance philosophy for the complete NADIN will depend upon the final equipment configuration as well as the chosen design options. The contractor's maintenance philosophy, as amended during contract negotiations, shall become a part of the contract and shall be implemented by the contractor in the NADIN system design. Detailed maintenance procedures shall be covered in the instruction books (Section 3.8.10) and used during the period of contractor-supplied maintenance (Section 3.6.4.)

3.6.3.1.1 Online Maintenance. Means shall be provided to detect any malfunction of system hardware or software elements that are in online active or redundant status. This detection shall be accomplished through hardware elements, software routines or a combination of both. This requirement is imposed on all NADIN system elements at the message switches and at the concentrators. It includes local and remote fault isolation techniques. The contractor shall ensure that the contractors-supplied NADIN equipment has the capability to operate with these diagnostics even if this capability is not specifically stated under that equipment's functional requirements. Upon detection of a malfunction of an online element, the system shall automatically switch to a redundant element or elements to form an operational system within 30 seconds, and resume operation without loss of traffic. Any failure of an online (active or redundant) hardware or software element shall cause, 1) a visual and audible alarm; 2) a dry contact closure suitable for activating a remote alarm; or 3) a hard copy printout identifying the failed element, any reconfiguration action taken and the time of day; or 4) any combination thereof as determined by the system operating personnel.

3.6.3.1.2 Repair of Failed Elements. Repair of failed elements shall be accomplished only when those elements are in offline or inactive status. Defective components shall be identified through use of special test equipment or through the formation of a test subsystem composed of offline elements. In no event shall online elements be used as part of an offline test subsystem except as specified by Section 3.6.2.2. Means shall be provided to verify that a repaired element is fully operational before it is returned to online or standby status.

3.6.3.1.3 Preventive Maintenance. The requirement that NADIN operate 24 hours every day places severe restrictions on preventive maintenance. The equipment shall be designed so that preventive maintenance can be performed on all units in an efficient manner. Preventive maintenance shall be performed on offline elements only (see Section 3.6.3.2.3).

3.6.3.2 Hardware Features

The NADIN equipment shall include hardware design features as required to meet the Mean Time to Repair (MTTR) as specified in Table 1. The following subparagraphs shall be included as design features in the NADIN equipment.

3.6.3.2.1 Mechanical Design. The equipment shall be mounted in cabinets that are easily opened to provice access to all test points and adjustments (see Section 3.10.1).

3.6.3.2.2 Electrical Design. Partitioning of logic shall be such that failures may be quickly isolated to a single replaceable module (see Section 3.10.1).

3.6.3.2.3 System Design. The interfaces between system elements shall include interlocks to isolate a maintenance subsystem from the online and standby elements to assure that the online and standby subsystem elements will not be affected by any maintenance procedure. A system maintenance console shall be provided at each NADIN switch and NADIN concentrator which will include trouble indicators, controls and visual indicator status for the maintenance interlocks, means for controlling system reconfiguration, visual indicator status of system configuration, and means for automatically printing out a log and the visual display of any alarm conditions that may be recognized by the online maintenance features described in Section 3.6.3.1.1.

3.6.3.3 Maintenance Programs

In line with the definitions of Section 3.6.2, the maintenance programs can be grouped into two categories, i.e., online maintenance programs and offline maintenance programs.

3.6.3.3.1 Online Maintenance Programs. These programs perform and control the online maintenance functions described in Section 3.6.3.1.1 and include the following:

a. (EX) Confidence Programs. Deleted.

b. Operational Diagnostic Programs. The diagnostic function will be performed upon detection of an error by the NADIN operational programs, or upon a hardware-initiated error interrupt. These operational diagnostic programs shall collect data as needed to verify a failure so that the offending element may be taken offline and the system reconfigured. Any pertinent information shall be printed out to provide a basis for repair. Storage requirements for these programs shall be added to those required by the operational program as described elsewhere in this specification (see Section 3.5.3).

ELEMENT	MTBF	MTBM	MTTR	SERVICE LIFE*
Central Processing Unit (CPU) will include power supplies	12,000 hrs	5,000 hrs	.75 hrs	10 yrs
Storage Element (SE)	10,000 hrs	5,000 hrs	.75 hrs	10 yrs
Input and Output Element (I/O E)	10,000 hrs	5,000 hrs	.75 hrs	10 yrs
Card Punch (CP)	750 hrs	300 hrs	.50 hrs	10 yrs
Card Reader (CR)	750 hrs	300 hrs	.50 hrs	10 yrs
Line Printer (LP)	1,000 hrs	500 hrs	.75 hrs	10 yrs
Magnetic Tape Transport (MTT)	1,000 hrs	300 hrs	.75 hrs	10 yrs
Disk Unit (DU)	1,500 hrs	750 hrs	.75 hrs	10 yrs
Keyboard Video Display Unit (K/DU)	7,500 hrs	1,000 hrs	.75 hrs	20 yrs
Cassette Element (CE)	1,000 hrs	450 hrs	.50 hrs	10 yrs
Modulator Demodulator (MODEM)	10,000 hrs	5,000 hrs	.25 hrs	10 yrs
Direct Dialing Element (DDE)	15,000 hrs	5,000 hrs	.25 hrs	10 yrs

* Certification or credible statements shall be provided to certify that the hardware elements meet or exceed the above R&M values during their service life.

TABLE 1

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c. Data Correction and Recovery Programs. These programs correct system operation after a failure. This corrective action might consist of a complete startover from saved data or simply a tape reread. These programs are conditional and would only be performed when requested by the operational system. The programs shall include suitable printouts to inform the operations and maintenance personnel of the specific action taken, the status of traffic and the status of the system. The storage requirements for these programs shall be added to those required by the operational programs as described elsewhere in this specification (see Section 3.5.3).

d. Reconfiguration Programs. The reconfiguring of the online elements would be performed by the reconfiguration program which would also accept requests to reconfigure from the operational diagnostic function when a non-clearing operational element failure has been verified. Information on the reconfiguration processes shall be printed-out to keep the responsible operating and maintenance personnel informed of the system status and the status of message traffic. The storage requirements for these programs shall be added to those required by the operational program as described elsewhere in this specification (see Section 3.5.3).

3.6.3.3.2 Offline Maintenance Programs. These programs shall consist of a large number and variety of comprehensive maintenance programs to be performed on offline elements or subsystems. They shall include routines to test all NADIN elements including the computer-oriented peripheral devices. A subset of these programs shall be oriented towards the preventive maintenance function discussed in Sections 3.6.2.2.2.1(a) and 3.6.3.1.3. These programs shall also include diagnostic routines to isolate hardware failures to a single replaceable module. Suitable printouts shall be provided to inform the maintenance personnel of the specific elements to be replaced. These programs shall also include certification routines to verify that repaired elements are fully operational before they are returned to an online active or redundant status.

3.6.3.3.3 Deliverable Maintenance Software Item. The comprehensive maintenance programs discussed in Section 3.6.3.3 shall be supplied by the contractor. An element reconfiguration program shall also be supplied (see Sections 3.6.3.3.1 and 3.7). The online maintenance programs discussed in Section 3.6.3.3.1 shall be integrated into the Operational Program Component (see Sections 3.5.5.3 and 3.5.5.4).

3.6.3.4 Offline Test Equipment

In line with the general maintenance philosophy of Section 3.6.3.1, sufficient offline special test equipment shall be provided to meet the reliability requirements stated in Section 3.7. The exact nature of this equipment will be dependent upon the hardware configuration and cannot be described in detail at this time. The offline test equipment

must be capable of isolating "normal" failures without the support of the redundant elements.

3.6.3.5 Switching Center Maintenance

Each NADIN switching center shall include maintenance facilities located in the equipment area. These facilities shall be equipped with individual cabinets and rack maintenance panels, visual alarms, patch panels, monitoring and test panels, equipment and controls for systems testing, monitoring, patching, fault detection and isolation, and system reconfiguration. The maintenance facilities shall have the capability to communicate with the operational equipment configurations and shall provide display and indications for system status information. Visual alarms on concentrator and modem status shall be included.

3.6.3.5.1 With Alarm Printout. The maintenance position shall include a KVDU terminal with characteristics as described for the KVDU terminal in the supervisory console (see Section 3.4.5.2.2). Status information shall be printed on a contractor-furnished medium-speed line printer(s). Fault information (including failures, configuration changes and outages) shall be displayed on the printer(s). The printer shall print status indications from the offline subsystem and operational switching center configurations. All alarm printouts shall be output, based on the event or condition being reported, to the appropriate printer or its designated alternate (selected by operator command).

3.6.3.5.2 Audible Alarms. An audible alarm shall be provided for all major fault indicators which may result in the halting of an operational processor (this includes both on-line and/or hot standby processors). Alarm cut-off keys shall be provided. A printout on the printer or visual display shall provide the identification of the faulty unit and the time of the fault in sequence as faults occur. If a fault causes any type of automatic restart, this fact shall be printed out along with any indications of hardware or software failure and the resulting configuration. A dry contact closure shall be provided concurrent with the audible alarm to activate the remote alarm (see Section 3.6.3.1.1). The contacts shall remain closed until released by the alarm cut-off keys at the maintenance position.

3.6.3.5.3 Maintenance Position Implementation. This equipment and associated maintenance programs shall be designed to provide the fault detection and repair characteristics necessary to ensure the reliability and maintainability requirements as specified in Section 3.7.

3.6.3.6 Concentrator Maintenance

Each NADIN concentrator shall include provision for hardware maintenance including the use of diagnostic programs. Patch facilities for external circuits (subscriber and concentrator to switch) shall be provided. Provision shall be made for testing and monitoring all circuits and equipment.

3.6.3.6.1 Control and Printout. As a minimum, two KVDU equipments, as described in Section 3.3.2.2.3.5.1, System Intercept Position Configuration, shall be included in the concentrator configuration. These units shall provide direct entry and hard copy and CRT display of outputs from the concentrator CPU as well as provide a capability for concentrator to switching center communication. Addressing of each concentrator shall be unique. As a minimum, printouts of failures, configuration changes, and outages shall be provided.

3.6.3.6.2 Alarms. A concentrator status and alarm panel shall be provided for online and offline configuration status indicators, plus fault alarm indication. All status and alarm indications shall be automatically reported to the message switches. Local alarm indication shall have remoting capability up to at least 600 feet. Only faults which cause switchover to the standby concentrator shall be indicated by way of audible alarms. All other faults shall be indicated by visual means, i.e., hard copy printout. Hard copy printout shall be output at the switch's printer and at the concentrator's printer. Software alarm indicators shall not be audible. All audible alarms shall be provided with a cut-off key capable of being remoted up to at least 600 feet. Operation of a cutoff key, whether local or remote, shall silence both the local and the remote audible alarms. Alarms shall be provided for all abnormalities in concentrator operation. In addition, alarms shall be provided to indicate abnormalities in terminal or communication channel operation, including such problems as:

a. Stuck tape
b. Continuous blanks or letters
c. Open line
d. Loss of carrier
e. Excessive errors on circuit - individual parameters by protocol are mandatory
f. Idle line or terminal
g. Modem fault

3.6.3.6.3 Implementation. This equipment and associated maintenance programs shall be designed to provide the fault detection and repair characteristics necessary to ensure the reliability and maintainability requirements as specified in Section 3.7.

3.6.4 Maintenance Services

When the contractor provides maintenance services for switching centers or ARTCC concentrators under this contract, the contractor shall provide all personnel and spare parts to maintain the contractor furnished NADIN system hardware and software on a 24-hour a day, 365-day a year basis to the level of performance and reliability required by this specification. (This does not imply a requirement for around the clock contractor maintenance at concentrator sites provided nodal availability and reliability can be otherwise met). All maintenance (hardware and software) down time during the 24-hour operational period shall be charged to the filed reliability criteria requirements of Section 3.7.

The contractor's Maintenance Service Plan shall describe his method of performing system maintenance and providing for operational redundant elements during 24-hour a day, 7-day a week operation, particularly in the areas of scheduled and unscheduled maintenance (see Section 3.6.2.2.2.1).

3.6.4.1 Maintenance Log

The contractor shall maintain a log of maintenance activities, outages, software patches, repair and spare parts used. Entries shall be reviewed and initialed by the Government's local technical representative. The contractor shall provide two copies of this log to the government's local technical representative on a weekly basis. After six months of operation, the contractor shall summarize the requirements for spare parts, based upon the maintenance log entries, and shall provide 15 copies of a recommended spare parts list and their consumption rate to the Government for support of the system for the second year of operation.

3.7 Availability

It is essential that the NADIN provide service to its users 24 hours a day, seven days a week with an absolute minimum of scheduled and unscheduled down time. This requirement for continuous operation is to be achieved through the use of:

a. System hardware exhibiting the highest level of reliability consistent with the requirement for use of off-the-shelf equipment (see Section 3.3).

b. Nodal architecture that provides high availability for each node.

c. Semiautomatic dial-up procedures for use in the event of a catastrophic failure at a node or loss of trunks between nodes.

3.7.1 Scope

The following paragraphs provide specific requirements to achieve the required level of system availability.

3.7.2 Availability Definitions

In general, the definitions given in MIL-STD-721 shall apply. For purposes of this procurement, the following definitions have been modified to be more specifically applicable.

3.7.2.1 Node Availability

A measure of the time that a node (message switch or concentrator) is operable processing all offered traffic and performing all of its specified functions. Node availability is expressed as the ratio of time available to total time.

3.7.2.2 Mean-Up Time (MUT)

The mean of the time that any item of equipment will remain in an operating state (online or online redundant) before a failure (either hardware or software) causes it to degrade from that state. MUT is expressed as the ratio of the time a piece of equipment is operable to total time.

3.7.2.3 Mean Down Time (MDT)

The mean of the time that any item of equipment will remain in a nonoperating state after a failure (either hardware or software) causes it to become inoperable. MDT is expressed as the ratio of the time a piece of equipment is inoperable to total time.

3.7.2.4 Transient Failure

Two classes of transient failures are defined:

a. Self-clearing transient disturbances, such as transient parity errors, which do not require substitution of a redundant element for an active element. Such transient disturbances are not to be considered in calculations of availability.

b. Nonclearing failures of an active element requiring deactivation of this element and its replacement by a redundant element, program reload, or any restart procedure. These types of failures form the basis for calculations of availability.

3.7.3 Hardware Reliability Requirements

In order to minimize the cost of maintenance, the following reliability requirements shall apply.

3.7.3.1 Hardware Reliability

Equipment used in the switching centers and concentrators shall be constructed of components exhibiting the highest level of reliability consistent with the requirement for off-the-shelf equipment. All components subject to failure shall be mounted in such a way that they are readily available for testing or replacement without removing any other components. Electronic components shall be mounted on plug-in cards for ease of servicing.

3.7.3.2 Failure Isolation and Repair

Repair time shall be kept to a minimum through use of special test equipment and program routines to isolate failures to a single plug-in module (see Section 3.6.3).

3.7.3.3 Minimum R&M Values for NADIN Hardware

Hardware elements meeting as a minimum the R&M values specified in Table 1 shall be provided if the contractor's system design includes such elements. If hardware elements other than those specified herein are used, the contractor shall provide MTBF, MTBM, MTTR data under the condition of a ten-year service life.

3.7.4 Nodal Availability Requirements

The NADIN message switching centers and NADIN concentrators shall be designed for continuous operation (24-hours a day, 7-days a week). Each message switch and each concentrator shall exhibit an availability of at least 0.9998. The following techniques are required and should help to achieve this required availability level.

3.7.4.1 Equipment Redundancy

Equipment configurations shall include sufficient redundant equipment to assure that no single failure will reduce system capacity below that required for full load and full functional operation. Means shall be provided to detect failures automatically in both active and redundant equipment. In the event of a failure in an active element, the system shall automatically reconfigure to form a new online subsystem from operable active and redundant elements, and resume operation within 30 seconds. No traffic shall be lost due to such a failure.

3.7.4.2 Peripheral Equipment Redundancy

Peripheral storage devices (i.e., magnetic tape units, disc files) and computer type input/output devices (i.e., card readers and punches, printers, keyboard devices) shall be operated on a pooled basis. Sufficient redundant elements shall be provided so that a single equipment failure is permissible in each class of storage or input/output device without reducing the capacity or functions at the facility.

3.7.4.3 Communication Interface Redundancy

Communication interfaces (i.e., interface devices, modems) shall be operated on a pooled basis. Sufficient redundant units shall be provided so that no single failure will reduce the communication interfaces of any type below the quantity assigned at that facility. In the event that multiple failures make it impossible to interface all the required communication channels, means shall be provided to deactivate channels in accordance with a preassigned priority sequence. Automatic reconfiguration of communication interface devices is not required.

3.7.4.4 Failure Detection

Automatic hardware and software features shall be provided that will automatically detect failures, errors, malfunctions, initiate automatic equipment reassignment reconfigure the system, and resume full operation within 30 seconds (see Section 3.6.3.1.1). Suitable alarms and printouts shall identify the failure and the action taken (see Section 3.6.3.5).

3.7.5 Network Availability

Semiautomatic dial-up capability shall be provided at NADIN message switches to provide protection from:

a. Catastrophic failure of a message switch (see Section 3.4.2).

b. Catastrophic failure of a concentrator (Protection provided for those users discussed in Section 3.4.7.8).

c. Failure of trunks (see Sections 3.3.3.4.1 and 3.4.8.6.1.16).

3.7.5.1 Operation

The dial-up capability shall be initiated by command from the operating personnel in response to local alarm conditions or information from another node. The specific dial up procedures shall be semiautomatically performed under program control.

3.7.5.2 Hardware

A direct dialing element shall be provided to allow the dial-up procedures to be performed for each required connection. Suitable modems (with speed selection and automatic equalization capability) shall be provided for each required dial-up connection.

3.7.5.3 Software

Programs shall be provided to control the establishment of required dial-up connections. These programs shall include control of the switch matrix to connect the direct dialing element and modems to the required telephone interfaces, control of the specific dial procedures, test of the acquired connection to assure operability, repeat procedures for use in the event that the acquired connection does not meet minimal standards, alarms in the event repeated dial-up attempts do not acquire a suitable connection, and coordination with other NADIN nodes to assure that procedures are modified to allow the dial-up channels to be effectively utilized.

3.7.6 Reliability and Availability Program

3.7.6.1 Reliability and Availability Program Plan

The contractor shall prepare and submit for approval a program plan developed in accordance with MIL-STD-785 Reliability Program for Systems, Equipment Development and Production, which describes the specific tasks to be performed to assure the reliability and availability of the NADIN system. This plan shall be submitted for inclusion as a part of the hardware design and configuration submission (see Section 3.8.4).

3.7.6.2 Reliability and Availability Calculations

The reliability and availability program plan shall include calculations of the MTBF, MTBM, and MTTR of the equipment proposed, and the nodal availability that will result at each message switch and concentrator. For purposes of calculating availability, the reliability and maintainability of all digital computing elements, storage elements, input and output elements, computer-oriented peripheral equipment, subscriber ports, trunk modems, and any other contractor-furnished items required for the proper operation of the NADIN shall be included in the calculations. The reliability and maintainability of Government-furnished equipment (GFE), uninterruptible power system (UPS), leased circuits, subscriber modems and any equipment whose failure would affect only a single subscriber circuit may be excluded from the availability calculations. MTBF, MTBM, and MTTR quotations are to be provided for all equipments to be furnished by the contractor. Any time lost following a failure (either a hardware failure or program stoppage) before reconfiguration or restart procedures return the node to full functional operation shall be considered as downtime for calculation of availability.

3.7.6.3 Reliability and Availability Program Content

The contractor shall perform tasks specified under the reliability and availability program plan. These tasks shall include the development of a suitable failure reporting program to identify, classify, and maintain statistics on all systems failures (both hardware and software), and for every failure, the symptoms, diagnosis, corrective action, and downtime. They shall also include the development of detailed preventive maintenance procedures and of techniques for isolating and correcting problems resulting from hardware and software failures. In addition, the program shall include detailed plans for analyzing failure reports to detect any failure trends.

3.7.6.4 Reliability and Availability Demonstrations

During the first year operation, the contractor shall demonstrate that the configurations provided, supported by the maintenance procedures developed, satisfy all the reliability, maintainability, and availability requirements specified herein.

3.8 Documentation

The contractor shall provide all necessary services and material to develop and deliver documentation in accordance with requirements specified herein. Documentation required by the various sections in this specification shall be developed in accordance with FAA-G-1210, Provisioning Technical Documentation, and shall be provided as specified in the applicable sections and the contract schedule. In addition, the contractor shall update all deliverable documentation to reflect the hardware and software design as of the date of system turnover to the Government at each site.

3.8.1 Documentation Contract Designation

All documentation produced or updated by the contractor shall show the contract number conspicuously displayed on each document, including drawings, to facilitate identification and association with the contract.

3.8.2 Quality of Reproducibles

All reproducibles furnished shall be of such quality as to permit the reproduction of every line and character on the reproduced copy. Reproducibles shall, to the extent possible, be on clean, white, smooth 8 1/2" x 11" commercial size paper suitable for use on standard commercial copy equipment. Drawings, photographs, or other artwork for illustrations, not readily copied on standard commercial copy equipment shall be ready for camera.

3.8.3 Progress Reports

Unless otherwise specified by the contract, the contractor shall prepare monthly progress reports and submit ten copies to the FAA. Preparation and submission of these reports shall commence the month following the date of contract and they shall be mailed to the FAA Contracting Officer no later than ten days following the reporting period. These reports shall include a concise statement of the work accomplished for the reporting period; a summary of the status of detailed design, fabrication, material orders, and tests of any deliverable items; a summary of meetings between the contractor and others participating in the program; special problem areas, including proposed solutions; and a brief statement of work planned for the next reporting period. A planned work schedule for the contract shall be submitted. It shall include the delivery schedule of all deliverable items and shall be revised as necessary in each report. Any delays that may affect the contract delivery schedules shall be fully explained.

3.8.4 Hardware Design and Configuration

The scope and complex interrelationship of FAA programs require early knowledge of the contractor's configuration. Therefore the contractor shall provide one reproducible and 8 copies of all data required hereunder to be submitted for review and comment, including the items specified in the subparagraphs below to the FAA contracting officer as per the contract schedule.

Review and approval shall be as specified in Section 3.8.11. The data submitted shall be organized to reflect the contractor's approach to achieving compliance with the more significant requirements of the equipment specification. This submission of data shall not be used by the contractor to propose modifications or alternatives to the details of the equipment specification or a change in scope of the contract. The data referenced below shall include all elements of the equipment to be produced by the contractor under terms of the contract, as detailed by the equipment specification and any addenda thereto, together with all interfaces with other equipment. A summary of equipment operational characteristics shall be included.

3.8.4.1 Block Diagrams

A complete set of equipment block diagrams shall be provided by the contractor. The block diagrams shall show the general operational, electrical, and physical relationships of the equipment elements.

3.8.4.2 Logic and Information Flow Diagrams

The contractor shall provide complete logic and information flow diagrams. These diagrams shall show the detailed logical, operational, and functional relationships of the equipment elements. Symbols used in these diagrams shall be fully explained in the basic document.

3.8.4.3 Input and Output Details

The contractor shall provide a document that consolidates all equipment input and output characteristics. This document shall include electrical characteristics of intersystem cables, signal characteristics and limits, and timing diagrams. These data shall include all major intrasystem as well as all external system interfaces.

3.8.4.4 Critical Logic

Where logic circuits are proposed that are of unconventional design, the contractor shall provide logic diagrams and a summary of the particular design approach.

3.8.4.5 Detailed Physical Description

The contractor shall provide a detailed physical description of the equipment. This description shall include weight, outline drawings, configuration, layouts, ventilation and air conditioning requirements, cable entry and exit features, clearance factors, power requirements, and other special details that should be considered for installation, operation, and maintenance of the equipment.

3.8.5 Index of Drawings and Technical Memoranda

The contractor shall maintain an index of all drawings and technical memoranda produced in connection with the maintenance, operation, and test of the equipment. This index shall be updated monthly and one reproducible and eight complete, updated copies shall be submitted to the FAA CO with the progress report specified in Section 3.8.3. Drawings and technical memoranda produced in connection with maintenance, operation, and test of off-the-shelf items that are in existence at the date of contract shall be submitted on a one-time basis with the first index. The contractor shall provide drawings or technical memoranda that may be requested by the FAA CO as listed on any index furnished in accordance with this requirement.

3.8.6 Installation Documents

The contractor shall prepare and submit to the FAA for review and approval, in accordance with Section 3.8.11, one reproducible and eight copies of documents containing all necessary information required by skilled technicians and engineers to install the equipment and initiate its operations. These documents may be selected data prepared under other documentation requirements of the specification or previously prepared documents for installation of like equipment. Submission of these installation documents to the FAA CO shall be per the contract schedule.

3.8.6.1 Site Preparation Specifications

Site preparation specifications shall be furnished in accordance with Section 3.12.

3.8.6.2 Site Installation and Cutover Plan

Site installation and cutover plans shall be furnished in accordance with Section 3.12.1, 3.12.1.1 and 3.12.2.

3.8.7 Acceptance Test Specification

The contractor shall provide a hardware acceptance test specification as a part of the overall acceptance test specification described in Section 4.2.1.1.

3.8.8 Test Reports

The contractor shall provide factory and onsite acceptance test reports as part of the test reports specified in Section 4.2.3.5.

3.8.9 Computer Program Subsystem Documentation

Computer program subsystem documentation shall be provided in accordance with Section 3.5 and include:

a. Computer Program Subsystem Design Data - Section 3.5.2.1
b. Computer Program Functional Specification - Section 3.5.2.1.1
c. Program Design Specification (PDS) - Section 3.5.2.1.2

d. Software Design Data (SDD) - Section 3.5.5.2
e. Operational Program Component System Operator's Manual - Section 3.5.5.3
f. System User's Manual - Section 3.5.5.4
g. Computer Program Operating System Manual - Section 3.5.5.5
h. Programmer's Reference Manual - Section 3.5.5.6
i. Peripheral Equipment Reference Manual - Section 3.5.5.7
j. Table Structure Manual - Section 3.5.5.8

3.3.10 Instruction Books

The instruction book manuscript and instruction books to be provided shall be prepared in accordance with FAA-D-2494/1/2/3 or the contractor shall furnish commercially available or developed books and shall meet, as a minimum, the requirements specified by the following subparagraphs.

3.8.10.1 Quality

The contractor shall furnish operator, program and maintenance manuals prepared in a careful and workmanlike manner in accordance with best practices (consistent with the intended use) as applied to similar manuals normally furnished for commercial equipment. Standard commercial manuals, as applicable, may be furnished with supplemental material as addenda to the standard manuals or may be provided as supplemental or separate volumes.

3.3.10.2 Contents

Each equipment item, i.e., memory, I/O element, interface adapter, power supplies, and each type of computer-oriented peripheral equipment shall be documented for operation and maintenance of the equipment. As a minimum, these manuals shall include (as applicable to each configuration ordered): maintenance schedules and procedures, including test points, complete logical and timing diagrams, schematic diagrams, complete parts list, complete connection breakdown by pin, expected oscilloscope wave forms that describe normal operation of each unit, site preparation requirements and installation information required to install the equipment and initiate its operation (including cabling, and connection diagrams and applicable information).

3.8.10.3 Preparation and Delivery of Instruction Books

Copies of initial instruction book manuscripts (commercial manuals plus addenda 3.8.10.1) shall be submitted to the FAA CO for review and approval. In addition to the books furnished and shipped with the equipment (see Section 3.8.10.4), reproducible and reproduction copies of the final books shall be furnished in accordance with the requirements of the contract schedule. Applicable corrections, additions, and deletions shall be made prior to printing of final books.

3.8.10.4 Instruction Book Delivery with Equipment

Copies of the final instruction book for each unit of equipment shall be furnished and shipped with the equipment, as provided for in the contract schedule.

3.8.10.5 Instruction Book Reproducibles

The instruction book reproducibles shall be on clean, white, smooth paper; drawings, photographs and other artwork for illustrations shall be complete and ready for camera.

3.8.10.6 Automated Documentation

Any documents (logic print, CPFSs, user's manuals, etc.) provided by the contractor that are generated by automation techniques shall also have the generating software and data bases included as deliverable items under the contract.

3.8.11 Documentation Review and Approval

After receipt of a preliminary document, the FAA CO will review and approve or direct any changes that are required to obtain conformity with this specification. The contractor shall change the document as necessary to conform with the requirements detailed by the FAA CO and shall resubmit corrected revisions for approval within fifteen days after receipt of the change requirements. In addition, the contractor shall, from time to time during the course of the contract, revise portions of applicable documentation as directed by the FAA CO or as deemed appropriate by the contractor, subject to the approval of the FAA CO. The contractor shall provide one reproducible and eight copies of all such revisions to the FAA CO no later than 15 days from the date of approval of the revision.

3.9 Cooperation and Coordination

The contractor shall participate in meetings and conferences, and shall exchange technical data relating to the equipment, software and system performance, and design compatibility with others as directed by the FAA CO. The FAA CO shall be furnished copies of all written communications concerning this contract between the contractor and the Government, and between the contractor and other contractors. The contractor shall participate, cooperate, and assist in resolution of technical interface problems with non-NADIN systems.

3.10 Design and Construction

The NADIN system shall be designed and contructed so that all performance, reliability, maintainability and availability requirements shall be achieved throughout the service life when operated within the specified environmental, mechanical, and electrical service conditions. The overall design and construction shall be accomplished in a simple and straight forward manner embodying principles of the best engineering practices as applied to off-the-shelf equipment manufactured for a similar intended use. The proposed NADIN equipment elements shall be commercial items which meet the off-the-shelf equipment definition (see Section 3.2). If the equipment meets MIL specifications, it shall be so indicated with a listing of the applicable MIL specifications.

3.10.1 Standardization and Interchangeability

Standardization of cabinets, racks, modular packaging, printed circuit cards, materials, processes and workmanship consistent with state-of-the-art technology of current generation solid-state devices including integrated circuits shall be used for all NADIN elements to the extent possible. Where redundant modules or elements are supplied that require online and offline reconfiguration, they shall be designed such that any of the modules or elements can fail or be serviced without affecting the operation of the other modules or elements. The NADIN equipment shall be mechanically designed and constructed to permit ready access to all modules, printed circuit cards, units or assemblies, etc. The construction shall be such that all parts, test points, terminals, and wiring are accessible for circuit checking, adjustment, maintenance, and repair without requiring the partial or complete removal of any adjacent module or unit.

3.10.2 Module Removal and Insertion Damage

All equipment shall be designed to enable the removal and insertion of modules and printed circuit cards without causing or inducing damage to any equipment external to the module or printed circuit card. This provision applies even if the module or printed circuit card is inadvertently inserted into the wrong module or card position.

a. Induced Transients: A means shall be provided to enable the removal or insertion of any module or printed circuit card without generating any logic or electronic disturbance that may affect the online system operation.

b. Expansion: A means shall be provided to enable the addition of modules and printed circuit cards to spaces previously assigned for expansion without causing any damage or inducing any transient condition as specified above (see Section 3.10.3).

c. Circuit Isolation: All circuits shall be designed so that no damage will occur when the equipment is operated with the operating controls and maintenance adjustments set to any possible configuration of settings. No failure shall occur due to activation of any operational controls.

3.10.3 System Growth and Expandability

If the requirements for system growth and expandability (see Sections 3.4.1.1 and 3.4.7.1(b)) are to include the addition of equipment cabinets or racks, prewiring of initially installed cabinets or racks to accommodate future expansion shall not be required. However, if interconnecting cables between existing cabinets or racks are required to be added to accomplish expansion requirements, terminations for these cables shall be provided in the existing cabinets or racks.

3.10.4 Ventilation and Cooling Equipment

Any blowers, fans, vents, and cooling equipment necessary for proper ventilation and cooling of NADIN equipment within the environment specified in Section 3.14 shall be furnished by the contractor. Each cabinet requiring forced ventilation shall contain its own blower system and shall require no external ducts. Ventilation air shall enter at or near the bottom of the equipment racks. The design shall be such that with access doors, equipment drawers, and plates open for up to eight hours, the equipment shall not overheat or develop hot spots exceeding allowable temperature rise. Each equipment enclosure using forced air cooling shall employ thermal warning alarm devices both locally and remoted to the maintenance position (see Section 3.14.2).

3.11 Spare Parts, Test Equipment, and Tools

The equipment shall be designed and fabricated so as to minimize any requirements for special test equipment and tools as well as keep the types of component parts, circuit boards, integrated circuits, and modules at a minimum to the extent feasible. Special test equipment and tools are defined as devices not readily available as commercial items.

3.11.1 Spare Parts

Spare parts shall be provided as specified in Sections 3.6.4 and 3.6.4.1 and in accordance with FAA-G-1375.

3.11.2 Test Equipment

The contractor shall supply with the design data a complete list of test equipment, standard and special, required for maintenance and repair of the NADIN system. Special test equipment shall be provided with the equipment as part of the basic equipment delivery. Standard test equipment shall be adequately described for easy identification and procurement from commercial sources. If ordered by the Government, the contractor shall also supply any standard test equipment with NADIN equipment deliveries.

3.11.3 Maintenance Tools

The contractor shall supply with the design data a complete list of all tools, standard and special, required for maintenance and repair of the NADIN system. Special tools shall be provided with the equipment as part of the basic equipment delivery. Common tools shall be adequately described for easy identification and procurement from commercial sources. If ordered by the Government, the contractor shall also supply any common tools with NADIN equipment deliveries.

3.12 Installation and Contractor Test

The contractor shall install and conduct contractor tests on each operational and FAA Technical Center switching center and concentrator ordered at each site designated by the Government. All sites will be within the Continental United States except for three concentrator sites (San Juan, Honolulu, and Anchorage control centers). Site preparation, including the furnishing and installation of any required air-conditioning, will be accomplished by the Government. The contractor shall provide the Government with one reproducible and eight copies of all necessary site preparation specifications. The contractor shall furnish all services, installation material, personnel, equipment, including contractor-owned test equipment (except Government offline test equipment in accordance with Section 3.11.2) and tools to install and conduct the contractor tests on each switching center and concentrator to include those at the FAA Technical Center. Installation and workmanship shall meet the standards of all national codes for this type of equipment. Upon completion of installation and contractor testing, preliminary acceptance tests shall be conducted by the contractor and shall be witnessed by the Government in accordance with Section 4. Preliminary acceptance of the system at the Government-designated site will be made after approval of all preliminary acceptance tests by the Government. Final acceptance of the system will be made after tests performed during the first year of operation which demonstrate the reliability requirements of Section 3.7.

3.12.1 NADIN Cutover Plan

The FAA shall be responsible for developing a cutover plan for all NADIN related FAA communication systems. The FAA shall perform cutover in accordance with the FAA's cutover plan (reference FAA Order 6180.4). The contractor shall support the FAA during cutover activities being directed by the FAA in accordance with Article V of the contract.

3.12.1.1 Master Site Installation Plan

The contractor shall submit a master site installation plan which details the specific approach, methodology, and procedures to be followed during installation and contractor test of the NADIN System. The plan shall include the methods, equipment and Government coordination required to ensure an orderly and planned set of guidelines that the contractor shall follow during all phases of installation and contractor test of the NADIN system. Each phase of development of the master site installation plan shall be closely coordinated with designated FAA project personnel. The plan shall be reviewed and approved in accordance with Section 3.8.11.

3.12.1.2 (former paragraph 3.12.1.1) NADIN Data Base. Deleted.

3.12.2 Site Installation Plans

The contractor shall submit the site installation plan for the specific site. The plan shall include FAA test and support personnel including communication and maintenance personnel required (see Section 3.12.2.1). The plan shall define all installation requirements applicable to each site. The contractor, as required, shall coordinate the site plans with designated FAA project personnel for that specific site prior to submission to the Government for review and approval in accordance with Section 3.8.11.

3.12.2.1 Personnel

Contractor personnel providing services at ARTCCs shall have a current U.S. Government clearance on file at the site prior to admission.

a. A test manager shall be provided by the contractor at each location. He shall control the conduct of the contractor test. However, any decision to change the scope or schedule of the test program will be implemented by the Government test coordinator.

b. Test and support personnel shall be provided by the contractor in addition to personnel furnished by the Government as indicated below in (c) and (d).

c. A test coordinator, provided by the Government at each location, shall have management control of the test configuration.

d. Test and support personnel, including communications maintenance personnel, will be provided by the Government at each location to augment the contractor's personnel during the conduct of tests. The intent of this provision is to reduce the contractor's peak manning which occurs during these tests. The requirements of this support shall be developed as a part of the Site Installation and Cutover Plan (see Section 3.12.2), which shall be subject to Government approval.

e. Personnel to support the government testing, to include cutover activities, shall be provided by the contractor as approved by the government. Cutover activities shall be as defined in the plan described in paragraph 3.12.1.

3.12.2.2 Site Installation Constraints at ARTCCs

All equipment required to complete a concentrator installation at an ARTCC must be on site prior to start of installation. When required, storage space will be provided by the Government for storage of the concentrator equipment prior to installation.

3.12.2.3 As-Built Site Installation Drawings

Site installation drawings covering all equipment installed and in place for each facility shall be provided. These drawings shall include, but not be limited to, power distribution cabling, signal and control cables, transmission cables, ground systems, floor plan, and equipment identification. One set of on-site, marked-up as-built drawings shall be provided to the Government prior to system acceptance at each site. Three sets of updated, as-built drawings shall be delivered to the Government within 30 days after acceptance at each site.

3.12.2.4 Government Furnished Facilities

The Government shall supply the contractor with those facilites such as reproduction equipment, office space, furniture, telephones, NADIN equipments and general office supplies essential for the timely performance of work hereunder while the contractor's personnel are performing at FAA facilities. The scheduling of the NADIN equipment at FAA facilities will be under the control of the Government. The contractor may be limited in the use of NADIN and FAA equipment on the prime shift. The contractor's personnel shall be prepared to work any shift utilizing NADIN and FAA equipment on any work shift in order to accomplish the contract work successfully. The contractor shall consolidate all of his equipment schedule requirements (NADIN and non-NADIN) into blocks of time. A facility utilization schedule shall be submitted by the contractor with the required blocks of time to the designated representative of the Government. The contractor shall identify the purpose for which the equipment will be required. The test configuration will be made available, as feasible, to the contractor except that prime shift availability may be limited.

3.13 Cabling

The contractor shall furnish all intra-unit and inter-unit cables, with cable connectors, required for factory test and for site installation and testing of the switching center and concentrator equipment including any special purpose test cables required for routine maintenance. Where patch panels or plug boards are used in the equipment, the contractor shall provide adequate plugs and patch cables required for normal equipment operation and special maintenance routines. Cables required for factory testing may be the same as those required

for subsequent equipment installation and testing. All connecting cabling for the switching centers and concentrators shall be designed for underfloor distribution. The contractor shall furnish and install all required cables at switching centers. Except as otherwise specified herein, the Government shall furnish and install all required cables at ARTCC locations in accordance with contractor furnished cabling criteria.

3.13.1 Power Cables

All AC power cables and wiring within the switching center and concentrator equipment shall be separated or shielded from the signaling circuits. Separate distribution circuits shall be provided for AC convenience outlets located in equipment cabinets. The power source for these convenience outlets shall be other than the critical equipment power bus. but, in accordance with NEC, the safety ground at the convenience outlet plugs shall be connected to the "critical" system safety ground. All AC power shall be installed in accordance with National Electrical Code NFPA-70-1975. Cabling shall also include all junction boxes, fittings, distribution equipment and switches, and circuit breakers from the FAA power distribution boxes to the switching center and concentrator primary power panels.

3.13.2 Interconnecting Cables

Cables connecting switching center modules and peripheral equipment within the switching center shall be terminated with connectors. These cables shall not exceed 300 feet in length and shall be designed for underfloor distribution. Connectors shall be provided with ten percent spare contacts. Connectors which have insert type contacts need only be loaded with contacts actually used, plus spares. Connectors shall employ common key at each cable end to prevent reverse mounting and its terminating socket must be clearly marked with the proper reference designations. Interconnecting cables for concentrator modules and peripheral equipment shall be as specified for the switching center.

3.13.3 Interface Cables

All switching center and concentrator interface cables to the facilities of a commercial carrier shall be terminated on Government- or carrier-furnished demarcation terminals located in the carrier's equipment room consistent with his current practices.

3.13.4 Inter-Cabinet Cabling and Wiring

Cabinet or rack interconnecting cables and wiring shall normally enter and exit in accordance with Section 3.13. Direct cabling through the sidewall of cabinets, at least six inches above the floor, may be utilized within a subsystem where distance is considered by the contractor a critical factor in circuit performance. Direct cabling shall not in any way compromise the requirements of expandability. The contractor shall provide cable entrances and exits with coverplates, where required.

3.13.5 Cable End Terminations

Signal cable end terminations shall be solderless, quick disconnect terminal blocks or solderless, wirewrap terminal blocks or connectors. Power cable end terminations shall be screw type terminal blocks, pressure contact terminal blocks, or connectors. Where connectors are used, each connector shall be provided with ten percent spare contacts. Connectors which have insert type contacts need only be loaded with the contacts actually used, plus spares.

3.14 Environment

Switching center and concentrator equipment shall be capable of implementation under conditions of the following subparagraphs.

3.14.1 Normal Test Conditions

The normal conditions for test of NADIN contractor furnished equipment at the test location elevation and with the relative humidity existing at the time of the tests shall be:

STANDARD DESIGN

PARAMETER	CENTER VALUE	TOLERANCE
Ambient Temperature	+22°C	+13°C
		-12°C
AC Line Voltage	120V	±2V
	208V	±3.5V
	240V	±4V
AC Line Frequency	60 Hz	±0.5 Hz
DC Voltage	48 V	±1V

3.14.2 Service Conditions

All contractor furnished equipment shall be designed to operate and maintain specified performance in accordance with indoor service conditions as follows:

Power source: 208 V/120 Volts ± 10% 60 Hz ± 2%

Duty: Continuous attended

	OPERATING	NON-OPERATING
Temperature	15°C to 35°C	-35°C to 60°C
Humidity	20% to 80%	5% to 95%
Elevation	Sea level to 6000 ft.	to 50,000 ft.

3.14.3 Available Height

All contractor furnished equipment shall be capable of installation within an established minimum room height of 8 feet with no restriction on the operation.

3.14.4 Weight

The total weight of the equipment shall be the minimum consistent with good design and economics. If possible, individual chassis of the equipment shall not exceed 40 pounds. Construction of equipment racks and housing shall provide for even floor loading distribution not to exceed 200 pounds per square foot and the average floor loading in any equipment area shall not exceed 120 pounds per square foot.

3.14.5 Identification Labels

Each NADIN equipment unit, typically a system element having its own on-off power control, shall have a nameplate. The design of the nameplate shall use FAA Drawing B-21216 as a guide. Equipment titles and nameplate locations must be approved by the CO prior to implementation. Each equipment unit nameplate shall have a serial number, by type of equipment, starting with "1" and continuing consecutively up to the total number of equipment units of that type supplied. The nameplates for equipment will be the standard company nameplate with a serial number corresponding to the manufacturer's serial number.

3.14.6 Exterior Finish

Preparatory cleaning for painted surfaces, priming, and finish painting shall be in accordance with FAA-STD-012. Ferrous surfaces shall be processed with system FS-1. All interior surfaces shall be processed in accordance with the system specified above through the prime coat of the color specified for exterior surfaces. On written request by the contractor, the CO will consider granting a waiver to this requirement provided the alternative proposed by the contractor is acceptable to the Government. Any waiver request shall include detailed data on the cleaning, priming, and finish painting. A sample paint chip shall be included.

3.15 Grounding Practice

The contractor shall follow the grounding practices specified in Appendix O of this specification.

3.15 Electromagnetic Interference Protection

At the contractor's option, the NADIN subsystems shall be designed such that 1) all the provisions of MIL-STD-461 are satisfied, or 2) the contractor can demonstrate that the operation of the NADIN will cause no malfunction or discernible interference to the operation of other equipment located in the same or nearby buildings at the site and the operation of such other equipment will cause no malfunction or discernible interference in NADIN (Section 4.2.3.8). The contractor may perform site surveys to evaluate potential interference problems.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Quality Control Program

The contractor shall provide and maintain a quality control program in accordance with the contract.

4.2 Acceptance Tests

Acceptance tests shall be in accordance with the following subsections.

4.2.1 General

The contractor shall perform hardware factory acceptance and onsite acceptance tests necessary to demonstrate that the switching centers, concentrators, peripheral equipment, and computer programs (operational and nonoperational) fully meet the requirements of this specification. The contractor shall not be required to test the interfaces during the live test environment of the system acceptance test time frame for interfaces which the FAA cannot provide a terminal.

If a terminal should become available during the RMA period, the FAA retains the option to schedule a physical test of the interface. If no terminal is available within 3 months of termination of the RMA period, the contractor shall deliver the interface design and implementation data for that interface to the FAA. This data shall include detailed design data, narratives, and source listings. The FAA shall analyze this data to determine the acceptability of how each interface is implemented by the contractor. The acceptance or rejection of the interface by the FAA will be determined by a detailed design review between the FAA and the contractor. The contractor shall furnish all test programs necessary for adequate testing of NADIN. Government furnished equipment will not be provided for factory acceptance tests with the exception that any deliverable items under the contract may be used.

4.2.1.1 Acceptance Test Specification

The contractor shall prepare and submit one reproducible and eight copies of a recommended acceptance test specification to the FAA CO for review and approval as specified in the contract schedule. The test specification shall:

(1) Identify all tests needed to demonstrate that the NADIN hardware and software meet all contract requirements.

(2) Identify the role of each test participant and observer.

The test specification shall be organized in functional test groups which shall as a minimum include the following for each group:

a. An identification of the individual tests within the group and their recommended sequence of performance.

b. An identification of the functions to be exercised and checked by each test. These functions shall be related to the specific paragraphs of this specification to which they refer.

c. Expected duration of each test group.

d. Use of special testing tools or program routines required for each test group.

e. An identification of the resources required for each test group, i.e.,:

1. Support personnel, both contractor and agency, (e.g., observers, console operators, communication specialists, maintenance personnel, computer programmers).

2. Support hardware, including computer elements and peripheral equipment.

3. Software resource requirements (e.g., data reduction and analysis).

Although certain tests may be impracticable at the contractor's plant because of the unavailability of input data (real or simulated), the test specification shall be comprehensive and complete regardless of whether tests are to be conducted at the contractor's plant or elsewhere (such as FAA facilities). The contractor shall recommend and identify tests to be conducted at his plant and those to be conducted elsewhere. The contractor shall include in the test specification proposed test dates and test sites for recommended contractor conducted tests. The FAA will review the test specifications within 30 days.

4.2.1.2 Acceptance Test Procedures

The contractor shall develop the detailed acceptance test procedures necessary for the performance of each test specified in the test specification. Each test procedure shall be submitted to the FAA CO for review and approval as specified in the contract schedule. As a minimum, these procedures shall include the following:

a. Requirements for program initiation.

b. Listing in time sequence of input data to be used during the test.

c. Listings in time sequence of operator (console and computer) actions.

d. Indications of environmental changes and conditions during test.

e. Documentation required to record each significant action in the procedures.

f. Method of testing and data collection for each test.

g. Data reduction and analysis techniques to be followed.

4.2.2 Factory Acceptance Procedures

Factory acceptance procedures shall be divided into two sections:

a. Quality control inspection.

b. Predelivery exercise.

4.2.2.1 Quality Control Inspection

This inspection shall include all checks and tests deemed necessary to ascertain that the NADIN meets highest commercial standards and all applicable requirements of this and referenced specifications.

4.2.2.2 Pre-Delivery Exercise

The contractor shall demonstrate compliance with all applicable requirements of this specification. These tests shall consist of individual unit tests and, where applicable, integrated NADIN system tests.

4.2.2.2.1 Contractor Preliminary Tests. Prior to the formal hardware acceptance procedures, the contractor shall perform preliminary testing on at least one switching center configuration and one concentrator configuration to assure that the equipment will meet all of the hardware initialization and diagnostic functions specific in the hardware and test documentation. These tests shall be performed using the approved test procedures, insofar as possible, to assure that these procedures are adequately checked out.

4.2.2.2.2 Preliminary Test Data. The contractor shall submit to the Government Contracting Officer a certified copy of the test data covering all the contractor's preliminary tests. This test data shall be submitted no later than 10 working days in advance of the date set for start of the formal hardware acceptance procedures.

4.2.2.2.3 Notification of Readiness. After submission of the preliminary test data, the contractor shall notify the Government Contracting Officer in writing that he is ready to conduct formal hardware acceptance procedures. Such notification shall be given in time to reach the contracting officer not less than 5 working days before the contractor desires the acceptance procedures to start. The Contracting Officer will arrange to have appropriate technical personnel present to witness the factory hardware acceptance test procedures.

4.2.2.2.4 Factory Acceptance for Production. A factory hardware acceptance test shall be performed on all NADIN system elements prior to shipment. At the option of the FAA CO, these tests may be a subset of tests performed on the initial equipment. A determination of which tests to perform in their entirety, which to perform in an abbreviated fashion, and which may be omitted will be made by the FAA CO based on the experience in testing the initial equipment. Within 30 days of the successful completion of the testing of each system, the contractor shall submit a formal test report (one reproducible and eight copies) to the FAA CO. These reports shall have the same form and content as indicated in Section 4.2.3.5.

4.2.3 Onsite Hardware Tests

Onsite hardware acceptance tests shall be performed at each site following installation. During onsite tests, the contractor supplied NADIN equipment may be connected to commercial power rather than to the UPS. The contractor is cautioned that his equipment must withstand voltage and frequency transients and other power irregularities normally associated with commercial power. The contractor will not be penalized if a commercial power irregularity interrupts an acceptance test.

4.2.3.1 Preliminary Tests

The contractor shall perform whatever inspection and preliminary testing he feels is needed at each site to assure that the installation is fully operational for final acceptance testing and thereafter ready to be cut over to active service. Upon completion of the preliminary testing, the contractor shall report in writing to the FAA Contracting Officer that the installation is fully operational and ready for final acceptance testing. Such notification shall be given in time to reach the Contracting Officer not less than 5 days before the contractor desires the final acceptance test to start. The Contracting Officer will arrange to have appropriate technical personnel present to witness the tests.

4.2.3.2 Onsite Acceptance Tests

Onsite acceptance tests shall consist of the acceptance test procedures (Section 4.2.1.2) as defined by the contractor and approved by the FAA CO. These tests shall be performed to assure that all site adaptation, e.g. port configurations, has been adequately implemented. In the event difficulties are encountered in the performance of these tests, the FAA CO may specify additional procedures to assure that the problems encountered have been adequately corrected. The contractor shall perform these additional procedures in addition to the acceptance test and adaptation test procedures.

4.2.3.3 Hardware Acceptance Exercise

The first NADIN equipment (two switching centers and four concentrators) shall be operated on operational sites using the approved test procedures for a minimum period of 120 consecutive hours, and shall meet all specified equipment requirements under existing ambient conditions of temperature and humidity. Maintenance schedules and allowable errors for this operational site acceptance exercise will be determined when the approved test procedures are submitted. During the entire 120 hour period the NADIN shall be tested with its power supplies at normal voltage to determine its susceptibility to external electrical noise. During the performance of the acceptance test exercise, the contractor shall record all results on approved test data sheets and log books. Upon completion of each test, the data sheets and log books will be initialed by the Government witness. The test data shall include the following information:

a. Test title

b. Date and time test started

c. Date and time test satisfactorily completed

d. Number of times, if any, that the test was not performed (completed) satisfactorily

e. Maintenance record

f. Acceptance by FAA designated respresentative.

4.2.3.4 Preventive Maintenance Demonstration Tasks.

Preventive maintenance tasks shall be performed at selected operational sites that is, one switch site and one concentrator site during the hardware acceptance exercise. The contractor shall develop a preventive maintenance plan, including all preventive maintenance tasks and the frequency at which they will be performed. These tasks shall be incorporated as part of the instruction book. Each preventive maintenance task shall be performed during the preventive maintenance demonstration. The time to perform these tasks shall be included in the contractor's Preventive Maintenance Plan. Equipment required for operational use (online) shall not be preempted for preventive maintenance, nor shall preventive maintenance demonstration tasks be performed on equipment which is in use in the online system. The ability to perform preventive maintenance without degrading system performance shall be demonstrated during the on-site final acceptance.

4.2.3.5 Hardware Acceptance Test Report

The contractor shall submit one reproducible and eight copies of the test report to the FAA within 30 days after completion of the tests specified in Section 4.2.3.1, 4.2.3.2, 4.2.3.3. and 4.2.3.4. In addition to a summary of the test procedures and results, the test report shall include copies of the test results as recorded on the approved data sheets. Appropriate supporting documentation, i.e., printer outputs, typewriter outputs, reports from data recording and observer's logs shall be submitted with the test reports (also see Section 3.8.8). If there are no adverse findings, the installation will be considered ready for cutover upon successful completion of the tests.

4.2.3.6 Reliability and Maintainability

The contractor shall demonstrate that the specified reliability and maintainability are met at each of the selected six RMA sites during the first year of operation. The maintenance philosophy of Section 3.6.3.1, maintenance programs of Section 3.6.3.3, offline test equipment of Section 3.6.3.4, requirements of Section 3.6.3.5 (switching center maintenance) and Section 3.6.3.6 (concentrator maintenance) and maintenance service of Section 3.6.4 shall apply during the year long demonstration of reliability and maintainability requirements of this specification. In the event reliability or maintainability requirements are not met, the contractor shall provide additional hardware elements, software improvements, procedural changes, or any other feature necessary to meet all reliability and maintainability requirements for each switching center and

concentrator delivered or to be delivered under the contract at no additional cost to the Government. Final acceptance of the NADIN will take place on successful completion of the reliability and maintainability demonstration.

4.2.3.7 Final Acceptance Tests

Final acceptance testing of the NADIN system shall commence with the on-site acceptance (Section 4.2.3.2) using the acceptance test procedures, (Section 4.2.1.2) as approved by the Contracting Officer. These tests shall begin after installation of all hardware and software and completion of all tests in 4.2.3.1 or at such earlier time as the Government in its sole discretion may determine. The tests shall demonstrate complete system configuration, operation and compliance with all requirements of the contract. The ability to perform preventive maintenance without degarding system performance shall be demonstrated during the final acceptance test. In the event difficulties are encountered in performance of these tests, the Contracting Officer may specify additional procedures to assure that the problems have been adequately corrected. These additional procedures shall also be performed by the Contractor. Prior to final acceptance test, the contractor shall demonstrate for FAA familiarizaton purposes all support and diagnostic software, including for example compiler, assemblers, text editors, etc. The contractor shall demonstrate, using the contractor developed operator/programmer manuals the following functions to be performed by the support and/or diagnostic software:

A. System build beginning with a source to object code assembly through preparation of the PLT.

B. Use of the Zilog (ZDS) interface system to the DS 714.

C. Use of all other functions in the support software library which were used to develop the NADIN software.

D. Use of all hardware diagnostic programs related to each hardware component of the NADIN system to isolate/ identify all hardware failures with their associated error messages, which the programs were designed for.

4.2.3.8 Electromagnetic Interference Tests

The contractor shall assure that the system is free of electromagnetic interference at each node (option 2 of Section 3.16). The site acceptance tests shall include specific procedures which demonstrate in an organized way that the NADIN is not affected by electrical or electromagnetic interference created by other equipment in the same or nearby buildings and that the operation of NADIN does not affect the operation of such other equipment. The contractor shall develop the procedures for these tests in conjunction with designated FAA personnal at each site who are familiar with the local electrical and electronic environment. These procedures shall be based on methods described in MIL-STD-462 and shall demonstrate that the requirements of Section 3.16 have been met. The results of these electromagnetic interference (EMI) tests shall be recorded in the hardware acceptance test report, (see Section 4.2.3.5).

4.2.3.9 Maintenance Records

During factory and onsite acceptance tests, the contractor shall keep a maintenance log which lists all malfunctions, their location in the system, and how they are repaired. Odd situations, such as cases in which malfunctions disappear for reasons not clearly understood, shall also be recorded. Ten copies of these reports shall be furnished to the FAA at the completion of the onsite acceptance tests.

4.2.4 Test Equipment

The contractor shall provide test equipment for contractor performed tests. These tests shall be conducted using special test equipment and maintenance tools supplied by the contractor in accordance with Sections 3.11.2 and 3.11.3. The contractor shall provide a list of test equipment and tools that FAA may provide for onsite testing. Items not available onsite (FAA-owned) shall be provided by the contractor for testing.

4.2.5 Inspection of Design and Fabrication Status

Upon request from the FAA, the contractor shall make available for review at his plant, at any stage of the contract, all pertinent information regarding the design and status of equipment being manufactured to this specification.

4.2.6 Facilities for FAA Inspection

When an FAA inspector is assigned to resident duty (two weeks or longer) at a contractor facility or a subcontractor's plant, the contractor shall provide facilities and services as specified in the contract.

5. PREPARATION FOR DELIVERY

5.1 Direct Shipment to a Site

Shipment of material from the contractor's plant to a specific site within the continental limits of the United States shall be via a moving van suitable for carrying delicate equipment. The contractor shall make all arrangements for shipment and delivery of the equipment and other contract items F.O.B. destination. The contractor shall be responsible for transportation and for moving all deliverable equipment, cable, and materials from his plants to their installation sites and positions within the buildings, or, first to FAA-designated local storage locations and later to their installation locations within the buildings. The FAA will not be responsible for such intermediate transportation and moving requirements, including moving such items from FAA loading docks to their installation positions.

5.1.1 Small Component Material

Small individual items or components shall be packed and marked both internally and on the exterior surface of the containers. If the unit is serialized, this identification shall also appear on the exterior surface of the container. Packing of this material shall be in accordance with MIL-E-17555, Level C.

5.2 Material for Inventory Storage

Material being delivered for inventory storage will be packed in accordance with the requirements of MIL-E-17555, Level A.

5.3 Packing of Systems or Subsystems for Storage

Systems or subsystems to be placed in storage at an FAA or Government facility shall be packed in accordance with MIL-E-17555, Level A.

6. INFORMATIONAL NOTES

Deleted entire section.